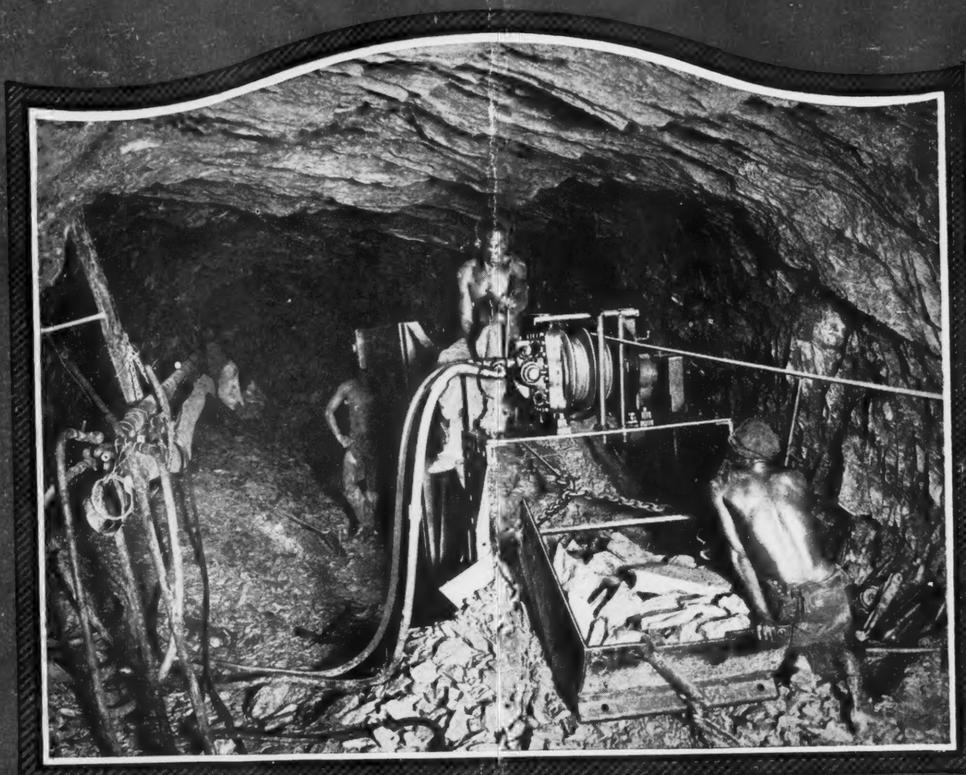
Compressed Air Magazine

Vol. XXXIV, No. 1 London New York Paris 35 Cents a Copy

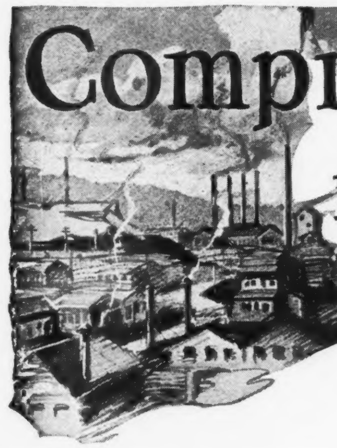
JANUARY, 1929
CIRCULATION THIS ISSUE
32,660 *COPIES*



LABOR OF SCRAPING ORE IN A SOUTH AFRICAN GOLD MINE GREATLY LIGHTENED BY THE USE OF AIR-DRIVEN "LITTLE TUGGER" HOISTS

(TABLE OF CONTENTS AND ADVERTISERS' INDEX, PAGE 26)


30174



Compressed Air Magazine

NEW YORK · LONDON · PARIS

Principal Offices
Bowling Green Building
No. 11 Broadway
New York.

VOL. XXXIV, NO. I

JANUARY, 1929

New Haven Goes Farther Afield for Water

New Haven Water Company Spending Millions of Dollars to Give the Elm City a Greatly Increased Supply

By R. G. SKERRETT

WHERE the dinosaur wandered 150,000,000 years ago, the New Haven Water Company is driving one of its tunnels deep below the ground surface in order to greatly amplify the supply now distributed through its network of mains to New Haven proper and to a number of surrounding communities dependent upon that enterprising company for its essential water.

There can be no doubt regarding the presence of dinosaurs in the dim past in that part of what we now know as Connecticut, because their footprints still survive in the buried sandstone that was an exposed and plastic mass when those strange creatures roamed in that region in quest of food. We shall touch upon this matter later on when we come to deal with the tunnel in question. In the meantime let us outline the growth of New Haven's water-supply system, and the steps that are now in hand whereby the available storage capacity of the system will be ultimately increased by substantially 300 per cent.

As far back as 1849 the people of New Haven started a movement looking to the creation of a public supply of water; but it was not until 1860 that anything was actually done to this end. Then, under the leadership of Eli Whitney and a few other earnest spirits, work was begun on the construction of a dam at Point of Rocks, on the Mill River, a little way north of New Haven and in Whitneyville. At that site, in colonial days, a gristmill was reared, and there both colonists and Indians carried their corn to be ground. The water impounded by that dam was pumped by water wheels to the reservoir on Prospect Street that still serves as part of the water-supply system of the "Elm City"—so well did the pioneers build.

Today, the New Haven Water Company furnishes water to approximately 250,000 people; and the daily consumption aggregates 28,000,000 gallons. Physical conditions have added to the problem of assuring an ample supply to the steadily increasing users dependent upon the system. That is to say, cities to the north and the west of New Haven have limited the region within which additional watersheds could be drawn upon to augment the resources. Successively, different areas have been made available by engineering undertakings of one sort or another, and these have been tapped so that the impounded water could be distributed through the various branches of the company's widely spread mains. Thus, since 1860, the New Haven Water Company has reached out until its present supply is obtained from several watersheds having a combined area of 92.2 square miles. The existing storage capacity is equivalent to about one-third of the annual consumption, and the remaining two-thirds must therefore be furnished by the flow of variable streams, some of which are marked by quick and sudden run-offs and able to provide but little water during periods of light rainfall or droughts. Owing to these circumstances, it became evident that something further would have to be done that could be confidently counted upon to provide a much larger reserve supply and one that would tend to stabilize seasonal fluctuations in flow. The North Branford Development is an outcome of investigations made to this end.

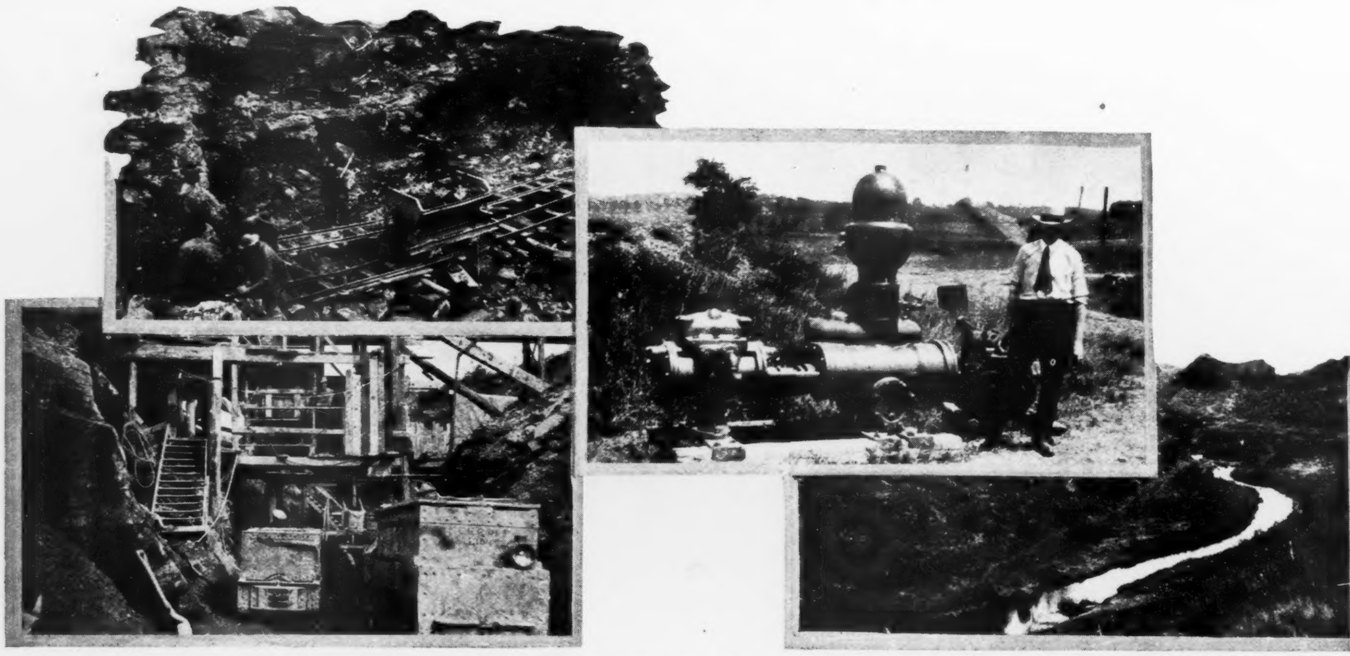
AT an estimated outlay of $3,000,000, the New Haven Water Company, of New Haven, Conn., is utilizing additional territory so that it will be able to insure its customers an ample supply of essential water under all seasonal conditions.

This is a fine example of foresight on the part of a New England public utility that dates back to 1860. In carrying forward the present undertaking the company is doing a work having many interesting engineering aspects. For instance, there are three tunnels that will have, upon completion, an aggregate length of 21,000 feet; and a reservoir has been created that is capable of impounding 15,000,000,000 gallons of water.

The project has been advanced with notable rapidity; and everyone responsible for the engineering plans and for their execution has reason for pride in what has been accomplished.

It should be of help to the outsider to be reminded that the population of New Haven was 81,298 in 1890, while in 1920 it had mounted to 162,537—virtually doubled in the course of 30 years. The growth of the "Elm City" has been a notably steady and healthy one; and its industrial life is a remarkably stable one and not subject to seasonal or periodic ups and downs as is the case with so many other communities. Therefore, New Haven's expansion during the past four decades, let us say, is a fairly reliable index of what will probably take place there in the years to come. The North Branford Development is, accordingly, part of a well-matured scheme outlined by the New Haven Water Company in anticipation of future demands. The plan calls for the prospective development of 53 more square miles of watershed; and the work actually underway now involves 18 square miles of this area.

The region to be so drawn upon consists

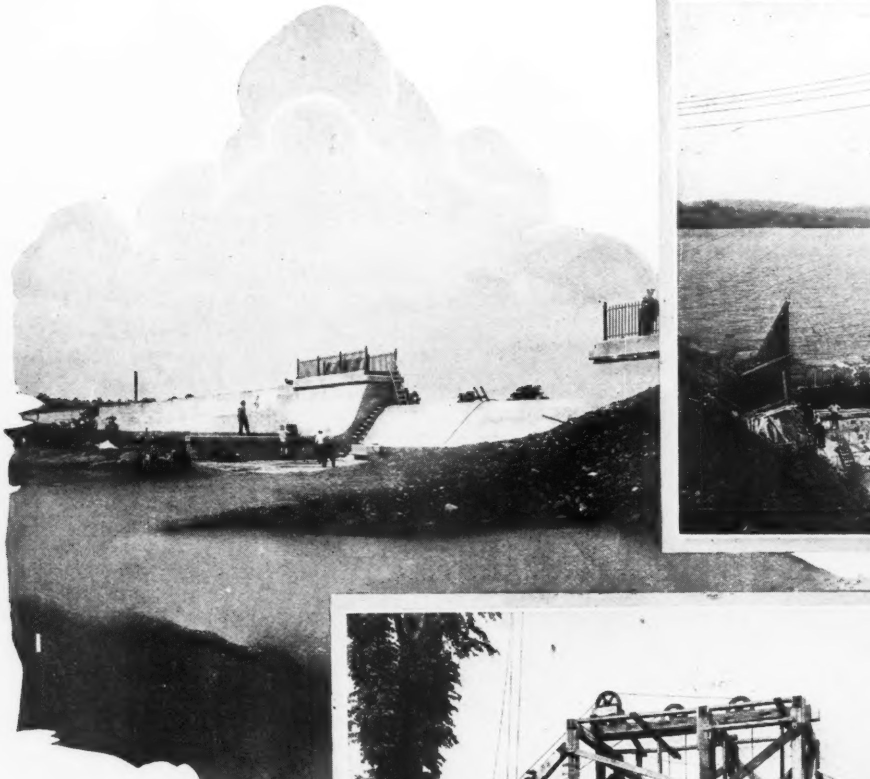


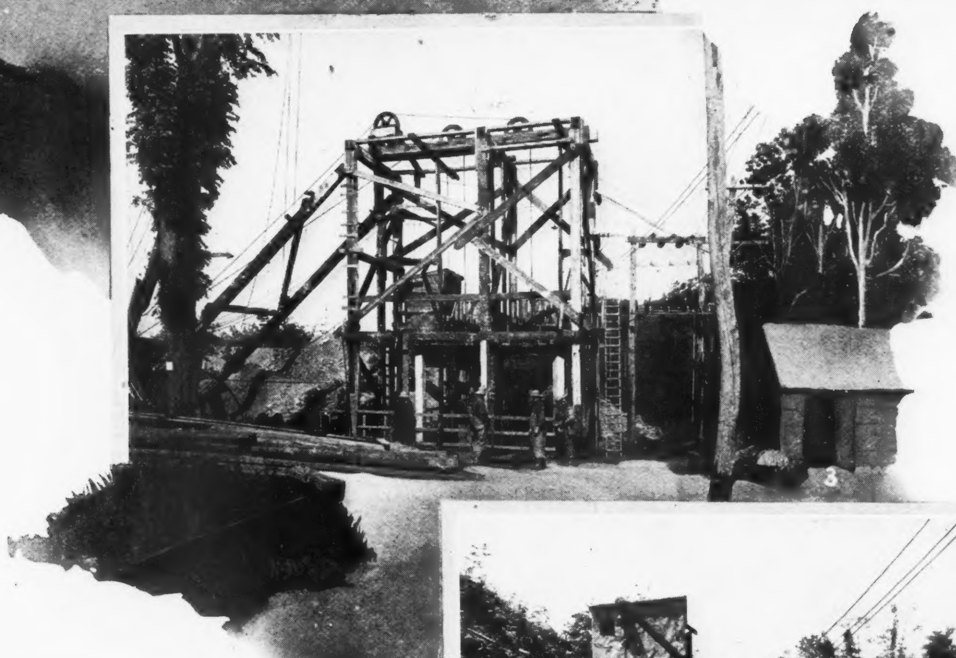
Top, left—Clearing away rock in the bed of the Menunkatuc River for the dam foundation. Right—Large Cameron pump on the North Branford Development. Bottom, left—Cement mixing plant at the west portal of the Sugar Loaf Tunnel. Right—The Menunkatuc River north of the dam that will divert the stream into the Sugar Loaf Tunnel.

of beautiful hilly country which, fortunately, is rather thinly settled. This latter fact has simplified somewhat the problem of acquiring title to the lands within the watershed or immediately adjacent to the impounding areas that must be taken over. As can be realized, the fundamental aim of the engineers is to create a balanced system that will permit of the utilization of both flashy streams and slower sources of water. Comprehensive measurements of stream flows on all the watersheds have disclosed with reasonable accuracy the amounts of water that may be expected from them over a period of years. It has been ascertained that, normally, about one-half of the rainfall is dissipated by evaporation and absorbed by plant life, while the remainder finds its way into the streams that drain the territory. The volume of the water carried off by the streams changes with the character of the country and the slope of the ground. Mill River, for instance, is a good example of a slow run-off. In a heavy storm, West River will yield twice the flow per square mile as Mill River; but in summer, when relatively little rain falls, Mill River will carry two and a half times as much water as West River. These differences in run-off have affected the designs of the storage reservoirs.

An accompanying map illustrates the entire projected North Branford Development; but the work now in hand extends no farther east than the portal of the siphon that will eventually run under the West River. The present contract calls for the driving of three tunnels having an aggregate length of 21,000 feet, and for the construction of three dams and of an extensive dike—the main dam and the dike serving to complete the Totoket

Top, left—Some of the big gate valves awaiting installation. Right—From left to right, Clarence M. Blair, engineer in charge for the New Haven Water Company; Harry Stokes, chief inspector; and Edward E. Minor, general manager of the New Haven Water Company. Bottom, left—Millstones used long ago in an old mill near the east portal of the Sugar Loaf Tunnel. Center—Easton dump cars removing muck from the Sugar Loaf Tunnel. Right—Gatehouse on the main dam.





1—East dike viewed from the downstream side near the spillway. 2—Totoket Reservoir, which will hold 15,000,000,000 gallon of water when filled. This picture was taken from near the site of the gatehouse. 3—Headframe at the shaft of the Sugar Loaf Tunnel. 4—East slope of the main dam of the Totoket Reservoir with backfill in place. 5—South portal of the Gulph Tunnel which connects with the Totoket Reservoir at the northwestern side of that great basin.

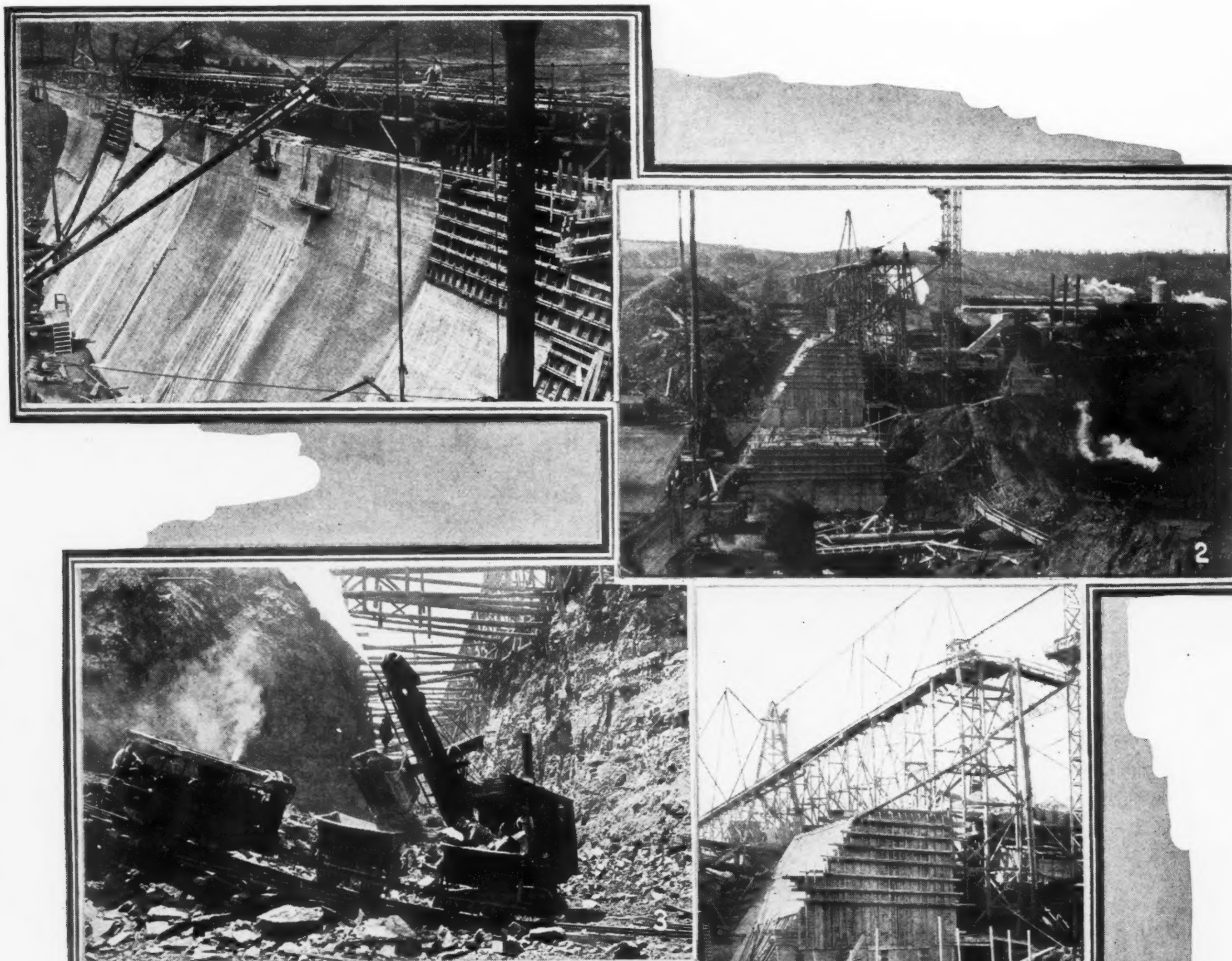
Reservoir and to prevent the natural escape of water into the Branford River. The execution of this great undertaking was awarded to C. W. Blakeslee & Sons, of New Haven, Conn., who started operations in December of 1925.

The Totoket Reservoir, when filled, will have a superficial area of 1,200 acres and be able to impound 15,000,000,000 gallons of water—75 per cent of which will be available to New Haven. By means of two tunnels that will discharge into its northern end, Farm River and Gulph Brook, to the west, and Menunkatuc River, to the east, will contribute their flows to the reservoir—two dams serving to block the water and to divert it into the connecting tunnels. At the south end of Totoket Reservoir a third tunnel has been driven through Great Hill, and this is linked to a 48-inch pipe line leading to the New Haven distributing system. The Great Hill Tunnel is finished, but the Gulph and the Sugar Loaf tunnels are not yet completed. The Great Hill Tunnel is 3,000 feet long and pierces both trap rock and sandstone. This conduit has a horseshoe cross section of 6 feet 4 inches, and is lined throughout with at least 9 inches of concrete. At the western end it is contracted so as to form a seal around the connecting 48-inch pipe line. The joints of this pipe line have been sealed with a composition called "Hydro-Tite", which is poured after it has been melted by heating. The concrete plant for the Great Hill Tunnel was located at the west end, where the raw materials were delivered over a railway spur of the New Haven Trap Rock Company.

The most spectacular feature of the Totoket Reservoir is the Totoket Dam. This dam is 1,200 feet long, and from the bottom of the cut-off to the crest of the structure is 120 feet high. The spillway level is 5 feet below the crest, on which there is a walkway 11 feet in width. The base of the dam has an up- and downstream spread of 80 feet. To insure a satisfactory foundation and suitable anchorages at each end of the dam it was necessary to excavate 55,000 cubic yards of rock. Before any of the concrete for the reinforced structure was poured, the supporting ledge was drilled to a depth of 15 feet with staggered grout holes placed 7½ feet apart. Grout was forced into these holes through 1½-inch pipe, and compressed air was used to do the work—the air being supplied by Ingersoll-Rand portables in batteries of three or four machines. The dam contains 91,000 cubic yards of concrete—the required crushed stone being obtained from the near-by quarry of the New Haven Trap Rock Company. Materials excavated in clearing the site for the dam have been backfilled against the downstream side of the dam. This serves two purposes: first, to add to the general stability of the structure, and, second, to protect that face of the dam from temperature changes, which are pronounced at times in that part of Connecticut. This provision will, undoubtedly, insure longer life to the concrete.

A second outlet of the reservoir area was closed by constructing a dike 1,800 feet long. This dike has a concrete core wall that extends from 18 to 20 feet below the normal ground surface; and this core wall is anchored to the underlying sandstone bedrock, of which only a few inches had to be excavated to insure the necessary bond. The core wall is 30 inches wide at the top, and has a batter on each side of 0.05 foot per foot. The dike has a spillway to provide for relief should the reservoir ever be filled to that level. The earth on each side of the core wall has been compacted by rolling. On the downstream side the earth was deposited in 12-inch layers and rolled, while on the upstream side the rolling was done in layers but 6 inches thick. The earth for the embankments on either side of

Top, left—Some of the R-72's drilling rock on the North Branford Development. Right—East portal of Sugar Loaf Tunnel adjacent to the Menunkatuc River. A dam will be reared at this point along the extended axis of the tunnel. Bottom, left—Steam shovels, gasoline locomotives, and dump cars at work adjacent to the east dike. Right—Where the Great Hill Tunnel tapping the Totoket Reservoir connects with the 48-inch pipe line which will carry the water seven miles to the existing New Haven system.



1—Downstream face of the main dam of the Totoket Reservoir before it was hidden by the backfill. 2, 4, and 5—Main dam at different stages during its erection. 3—Gasoline locomotives and dump cars hauling excavated rock from the cut made for the main dam. 6—Upstream face of the main dam when nearing completion.

Attractive vistas of picturesque New Haven and of the Menunkatuc River when flowing tumultuously during a freshet period.

the core wall was obtained by stripping the land within the Totoket Reservoir to the prescribed flow line.

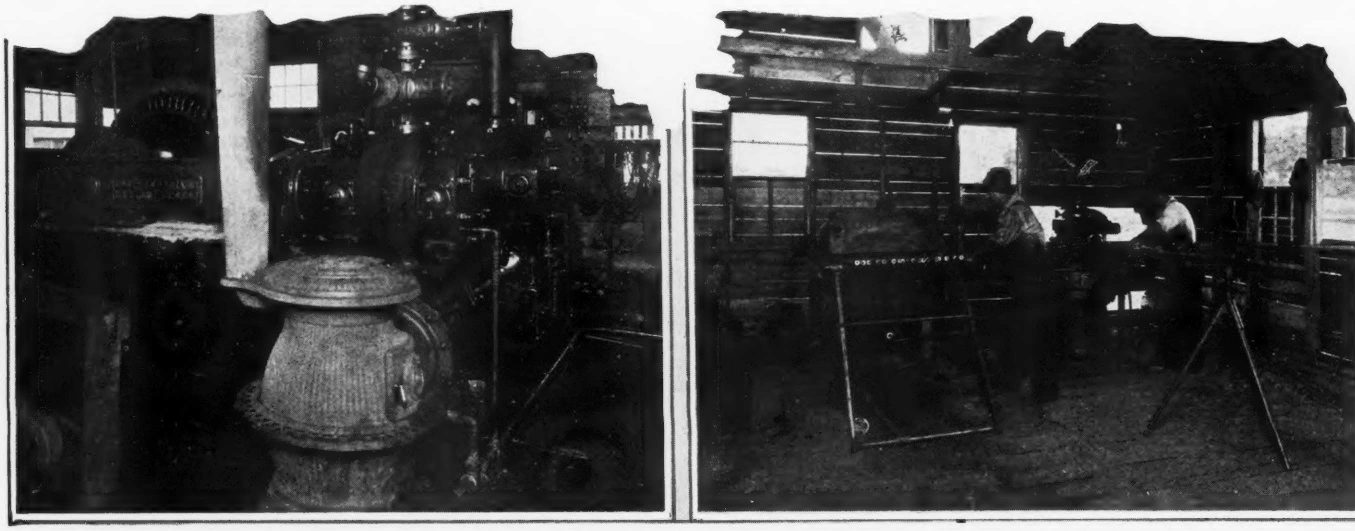
The mile-long Gulph Tunnel is 7 feet 8 inches in section, and as it penetrates hard trap rock there will be no need to line it. The drilling is being done at one heading, advancing northward; and an average footage of 18 feet is made daily with two shifts. The mucking is done with Conway electric muckers; and the muck is removed in Easton 2-cubic-yard cars hauled by Atlas storage-battery locomotives. The headings are ventilated by Sturtevant blowers delivering air through 12-inch ducts. This tunnel will link the Totoket Reservoir with the watershed of Gulph Brook and Farm River.

Of the two tunnels tributary to the Totoket Reservoir, the Sugar Loaf Tunnel—running under Sugar Loaf Mountain—is the longer and the larger. From portal to portal it is 13,500 feet in length; and its excavated cross section is ample enough to provide for a finished, lined section of 6 feet 8 inches by 6 feet 8 inches—the concrete lining to be not less than 8 inches in thickness. This tunnel has been driven through a sandstone formation; and it was while working in its western end that a keen-eyed geologist observed the dinosaur footprints exposed in the roof. Technicists of the Peabody Museum of Natural History of Yale University have since closely followed succeeding revelations; and Prof. Malcolm R. Thorpe, curator of the museum, says: "We have identified seven genera and twelve species of tracks, some of which are new to Connecticut and all but three of which are in a geological horizon approximately 1,000 feet lower than any previously recorded from the entire Triassic area. There are about fifty footprints, ranging from approximately 1 inch long to nearly 2 feet, representing reptiles, dinosaurs, and probably amphibians."

To expedite operations on the Sugar Loaf Tunnel, a shaft 95 feet deep and 10x20 feet in section was sunk on the tunnel line at a point 5,200 feet east of the west portal which is near the north end of the Totoket Reservoir. This shaft permitted the driving of two additional headings—making four all told. The headings between the shaft and the west portal were holed through last June, and those between the shaft and the east portal were holed through in September. On this job it was the practice to use 22 holes to a round with a regular center cut—the holes being generally 13 feet deep. This made it possible to pull 10½ feet at a round; and two rounds were pulled daily at each heading. Two drills, mounted on columns, did the work at each heading; and the drills employed were R-72 drifters. As can be seen, with continuous operation, the procedure was to drill and to muck a heading every twelve hours. Mucking was started at 7 a.m. and at 7 p.m., and completed, respectively, at noon and at midnight. During one period of 27 days, at two headings, 1,169 feet were drilled—two drilling shifts and two mucking shifts alternating, that is, one shift mucked one heading while the drilling shift worked at another. The blacksmith shop at the shaft of the Sugar Loaf Tunnel was called upon to recondition 120 steels daily—the steels being 1¼-inch, hollow, round. For this work the shop was equipped with a No. 25 oil furnace, a No. 50 "Leyner" sharpener, and a No. 8 pedestal grinder.

Although the Sugar Loaf Tunnel pierces relatively soft sandstone, still the ground required only infrequent sets of timber. These were needed principally where water-bearing veins were encountered. This water was run

Glimpses here and there of Yale University. Lower left is a diagram of a typical drill round used in driving the Sugar Loaf Tunnel.



Left—XRE compressor furnishing air at the shaft of the Sugar Loaf Tunnel. Right—One of the several blacksmith shops on the North Branford Development showing a typical air-operated plant consisting of an Ingersoll-Rand oil furnace and a "Leyner" sharpener.

to sumps and drained therefrom by electric or air-driven pumps, which were called upon to handle about 250,000 gallons daily. Three Conway mucking machines were used in the Sugar Loaf Tunnel, and Easton muck cars were utilized to move the muck either to a 2-cage hoist at the shaft or to dumps outside the east and west portals.

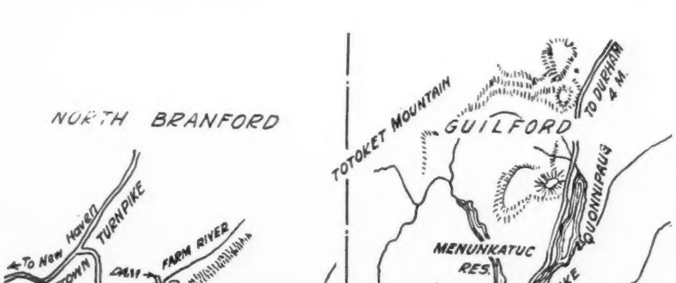
The lining of the Sugar Loaf Tunnel has been progressing rapidly for some time—the lining being done from the shaft westward to the west portal. There a concrete mixing plant has been so erected that the concrete can be chuted directly into Atlas dump cars spotted beneath it. Eight ¾-yard cars constitute a train, and are hauled by electric locomotives. The concrete is placed pneumatically by a Ransome 14-cubic-foot machine. Blaw-Knox forms are used—each form section being 5 feet in length; and twenty of them are assembled at a time. That is to say, 100 linear feet of tunnel is lined daily in the course of a 9-hour day. The concrete for the sides and the arch is shot into the forms by means of air at a pressure of about 90 pounds, while the invert is first poured by gravity.

The east portal is at the Menunkatuc River, where a concrete dam 60 feet high and 250 feet long will close the valley and convert it into a reservoir capable of impounding 350,000,000 gallons of water. The Menunkatuc River is a flashy stream; and the rise in the reservoir will be rapid during periods of heavy rainfall. The Sugar Loaf Tunnel will serve to offset this by providing a capacious duct through which this water can be delivered by gravity to the far more extensive Totoket Reservoir. The Sugar Loaf Tunnel will also run through the Menunkatuc Dam and connect with a siphon that is to underrun the West River and, eventually, with the Genesee Tunnel which will, when driven, extend the system five miles farther eastward to the proposed Hammonasset Reservoir. In its course, this projected tunnel will tap two small streams.

Broadly stated, the work now in hand, involving an estimated outlay of $3,000,000, will be finished by the close of 1929; and the intention is to use the development primarily for storage purposes until the demand has reached a stage necessitating the daily withdrawal of water from the Totoket Reservoir.

An ample supply of pure water is a fundamental necessity, and it was recognition of this fact that brought the New Haven Water Company into being in 1860. Since then that company has done everything in its power to protect the consumers in every way—seeing to it that there was sufficient water for domestic and for industrial purposes, as well as to prevent the spread of fire. The present great undertaking is merely recurrent evidence of the company's vigilance and foresight.

The contractor, C. W. Blakeslee & Sons, is directly represented by Clarence Blakeslee, with W. H. Ryan as general superintendent. The New Haven Water Company is represented by Edward E. Minor, its general manager, and by A. B. Hill, its consulting engineer. Clarence M. Blair, of Mr. Hill's staff, is engineer in charge for the water company.



General plan of the North Branford Development of the New Haven Water Company.

LIGHT RAYS AUTOMATICALLY CONTROL TRAIN SPEED

An automatic train-control system of a new order has been devised by a Munich engineer that is now being tried out on a stretch of the German State Railways by a committee especially appointed for the purpose. A selenium cell, acted upon by light rays emanating from the locomotive cab, is made use of by him to control the speed of a train.

As described in *Transportation*, the light successively strikes a group of mirrors placed along the roadway. If there is danger ahead and the approaching section or block is closed, the rays are transmitted to the selenium cell, which is thus made to close an electric circuit that automatically operates the brakes. The mirrors are of special construction, and are said to be absolutely reliable under all weather conditions.

The arrangement is such that the train is brought to a stop gradually. This is accomplished by varying the distance between the mirrors so that the speed of the oncoming train is first reduced to about 37 miles, then to 25 miles, 12 miles, and so on until it comes to a halt as the last of the four mirrors is left behind. It has been recommended that the system be used to automatically cut down the speed of trains at dangerous curves so as to lessen the chance of derailment.

Air-Operated Spike Pullers Speed Track Work

By THE STAFF

THE ERIE Railroad not long ago staged a demonstration to show officials of other railroads the method and the up-to-date facilities employed by it in rail-laying work. What was done on that occasion illustrates the steadily widening use of compressed air and air-operated tools in this essential department of maintenance of way.

The rails laid at that time were each 39 feet long and weighed 110 pounds to the yard, or, to express it otherwise, each rail weighed 1,430 pounds—a pretty heavy mass of steel to be shifted into position on the ties. That weight also indicated what modern railroads are doing to provide sufficient strength to meet the present-day requirements of heavy and speeding trains.

I-R spike puller with jaws just about to grip the head of a spike before pulling it.

The relaying of rails on a busy line must be done with dispatch; and for that reason maintenance-of-way departments look favorably upon any piece of equipment that promises to help to speed up track work; but they must be satisfied that the tool will do all that is claimed for it before it wins adoption. Compressed-air-operated tools—such as wrenches, rail drills, bonding drills, spike drivers, and tie tampers—are used widely today; and they have done much to facilitate rail laying and, besides, to lighten or to lessen the muscular demand upon the workers. Incidentally, they have brought about substantial savings. To this array of pneumatic tools, designed particularly to aid in the upkeep of roadbeds, has lately been added another unit—an air-driven spike puller—that has proved that it can further reduce the time required to take up old rails and to lay new ones in their stead. Tools of this description figured conspicuously in the relaying demonstration referred to in the opening paragraph.

Before giving details of that performance, it might help to a fuller grasp of what was done on that occasion if we describe in general terms the main features of this spike puller which has been developed by the Ingersoll-Rand Company. As one of the accompanying pictures shows, the equipment is a 1-man, portable tool, having an over-all length of 30½ inches. Air at a pressure of from 80 to 90 pounds—depending on the holding power of the spike—is required to operate the puller which, so it seems, consumes on an average only 3 cubic feet of air for each spike pulled. This low air consumption makes it practicable to drive the spike puller from an Ingersoll-Rand tie-tamper compressor without slowing up the work of other pneumatic tools being used on the line at the same time.

The spike puller consists fundamentally of an air cylinder, jaws to engage the spike head, and a suitable base or rail grip. In service, the machine—with its jaws down and open ready to grip a spike head—is placed with its base resting on the flange of a rail. In this position, air is admitted to the cylinder so as to force the piston upward. The pull thus exerted is increased fourfold by a system of toggle links before it is applied to

Left—The pneumatic spike puller does not bend the spikes in withdrawing them from a tie as does the claw bar. Right—Ingersoll-Rand portable compressor equipped with overhead air-supply apparatus mounted on wheels.

Full working equipment used in track-laying work on the Erie Railroad—the portable compressor furnishing air for tie tampers, bolt wrenches, spike drivers, rail drills, and spike pullers.

the jaws, causing them to close on the spike head and, when firmly engaged, to withdraw the spike from the tie.

In order to obviate the use of long air hose, leading from the compressor to the pneumatic tools, the demonstration on the Erie Railroad included the testing of an overhead air-supply apparatus, the general nature of which is plainly indicated by one of the accompanying illustrations. The air was distributed through piping forming part of the framework of this novel equipment, which was so arranged that it could be moved along the rails on four supporting wheels. Air valves were provided at convenient points in the overhead piping; and at any of these points short lengths of hose could be connected—the hose being long enough to meet all

	First Day		Second Day	
	Men	Working Hours	Men	Working Hours
Pulling spikes by hand	6	62½	6	63½
Pulling spikes with air puller	4	36½	3	29½
Throwing out old rail	7	67½	7	67½
Adzing ties for new rail	5	50	5	50
Plugging ties	2	19½	2	19½
Setting in rail with locomotive crane	6	54	6	60
Setting spikes for air hammer	11	96½	10	89½
Spiking by hand	2	18	2	20
Spiking with air hammer	5	47½	5	47½
Applying bolts	4	36½	4	36½
Tightening bolts with air bolter	3	27	3	30
Unbolting old rail with air bolter	3	27	3	30
Applying 3,560 rail anchors	4	34	5	51
Taking off old rail anchors	2	18	2	18
Total	64	594½	63	612½
Traveling time to and from work, which was done by bunching regular track gangs		61		59
Tie-tamper operators	2	24	2	24
Locomotive-crane operator	1	10	1	10
Total	67	689½	66	705½

	First Day	Second Day	Total
Total number trackmen	56	55	111
Man-hours worked	518¼	533	1,051¼
Total number track foremen	8	8	16
Man-hours worked	76¼	79½	155¾
Total number machine operators	3	3	6
Man-hours worked	34	34	68
Total feet of rail laid	17,280	17,319	34,599
Average feet rail laid per man-hour	27.5	26.6	27.1
Average feet rail laid per man-hour, covering actual time worked in two days, exclusive of labor in applying rail anchors and unbolting old rail			30.5
Average feet rail laid per man-hour, including traveling time	25.0	24.5	24.8

Note: No work was done in advance of rail-laying operation except to distribute material and to hang angle bars on one end of rails. Outside lines of spikes pulled.

requirements. The new rails were placed in position by a locomotive crane. The demonstration took place on two days, and the working period in each case was a day. The accompanying tables give the number of men required for the different jobs and the total time consumed.

Additional evidence of what the pneumatic spike puller will do was given by one of these machines that was put to work on a double-track main freight line of a large Middle Western railroad. The line was built nineteen years ago and, with the exception of a short stretch on a curve, the original rails were in place until early in 1928. Ninety per cent of the ties were of white oak; and $\frac{5}{8}$-inch spikes were used with tie plates punched for $\frac{9}{16}$-inch spikes—conditions tending to increase friction when the time came to withdraw the spikes.

The records show that the pneumatic spike puller made it possible, at 1-minute intervals, to pull as many as 8, 9, 11, and 14 spikes, or an average of 6 spikes per minute throughout a continuous period of four hours. By way of contrast, it was found that the best the ordinary claw bar could do was an average of 3 spikes per minute—indicating a 100 per cent better performance on the part of the air-operated spike puller. The tests also brought out that the spikes withdrawn by the air-operated machine were straight, while those removed with the claw bar were bent.

The Second National Highway Congress and Exposition, held in Mexico City, Mexico, late last year, was skillfully conducted and made doubly effective by its many interesting exhibits. The exposition was well attended; and in every way gave evidence of the earnest attention now being devoted to the development of the country's highways. The picture above was taken during an official visit of the delegates to one of the outstanding exhibits.

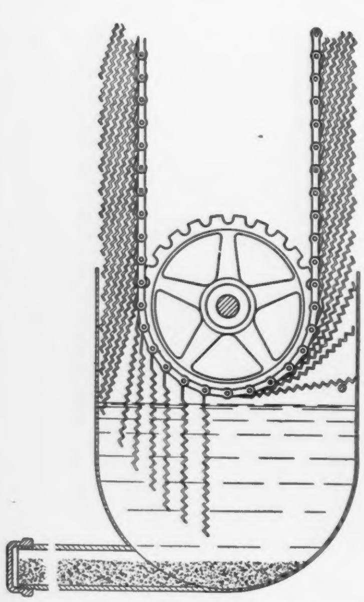
NEW AIR FILTER FOR ENGINES AND COMPRESSORS

THE Reed Air Filter Company, of Louisville, Ky., has developed and recently put on the market a heavy-duty air filter that is especially suitable for continuous service on oil engines and air compressors. This air filter is entirely automatic in its action and embodies, so it is claimed, a new self-cleaning principle that prevents any possible oil entrainment.

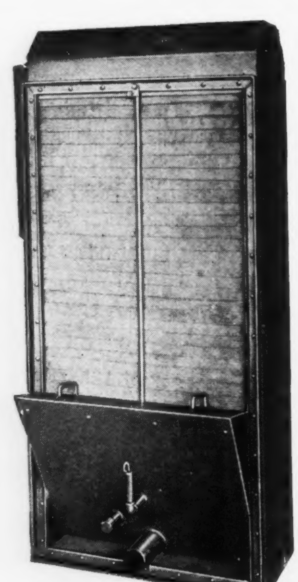
According to the manufacturer, the filtering media consists of a continuous curtain of double woven-wire panels overlapping, six deep, like shingles on a roof. The panels are carried between $\frac{1}{4}$-inch rods which extend the full width of the filter and are spaced $1\frac{3}{8}$ inches apart, thus forming a substantial reinforcement for the media. Because the air is forced to pass twice through these six double panels, 24 impingements are assured. This is said to account for the high efficiency of the filter ranging from 97 to 99 per cent.

To neutralize the effect of air pulsations and sudden changes of velocity, the filtering media is mounted on heavy chains and moved across the air passage between rigid angle-iron slides—the rate of travel being only $\frac{3}{4}$ inch every 12 minutes. Just before reaching the cleaning tank at the bottom of the filter casing, the panels are automatically separated and individually plunged down into and through the filter oil. The separation of the panels serves to loosen the dust deposited on them, and the force with which the panels strike and pass through the oil tends to cleanse them thoroughly. After that the panels are automatically reassembled for the next circuit.

Units are made for capacities ranging from 2,800 cubic feet per minute to 20,000 cubic feet per minute. As the filters are small and compact they require little space; and they are said to be easy to install.



Cross section of the filtering screen, showing how the overlapping panels are automatically separated, cleaned, and reassembled.



New Reed self-cleaning air filter designed especially for use on oil engines and compressors.

WELL-DRILL HOLES SERVE DOUBLE PURPOSE

ON a large-scale rock-excavating job, writes W. L. Home, mining engineer, in *Rock Products*, two inclined raises were driven from a tunnel level, 250 feet below the surface of the ground, up to the surface. Upon getting the raises partway to the top, the problem of ventilation and of getting the drill steel to the backs of the raises became important factors. The same problem may be met sometimes in the operation of limestone or gypsum mines.

Although ventilating fans were run almost continuously—the work being done in three shifts—much time was lost due to bad air. Letting drill steel down the shaft, hauling it to the manways, and hoisting it up in the stopes was a mean, slow, and costly job. Transportation of the steel from the tops of the manways to the backs of the stopes also presented difficulties.

To assist ventilation, a series of large-diameter well-drill holes were put down so as to hole through always as near the back of the raise or stope as possible. It was then found convenient to let down all the sharp steel through these well-drill holes and to hoist up the dull steel. This made for a minimum amount of handling, and always landed the steel close to where it was to be used. The hoisting outfit consisted of a portable air hoist that could be moved from hole to hole; of a tripod or headframe made of three pipes; and of a carrier fashioned of a piece of 8-inch pipe provided with a bail and a bottom.

Up-To-Date Drillboat Marks New Era in Excavating Submerged Rock

New Equipment On U. S. Government Drillboat "No. 426" Makes Possible Great Operating Economies

By A. L. RICHARDS*

MUCH work has been done and efforts still continue on a considerable scale to render the Mississippi navigable to good-sized craft at all stages of water. Physical conditions in various parts of the river have seriously hampered and even menaced the movement of vessels at times; and the purpose of this article is to describe the methods employed by the United States Government in improving a particular section of the river. We refer to that reach lying between Le Claire, Iowa, and Rock Island, Ill., a distance of fourteen miles.

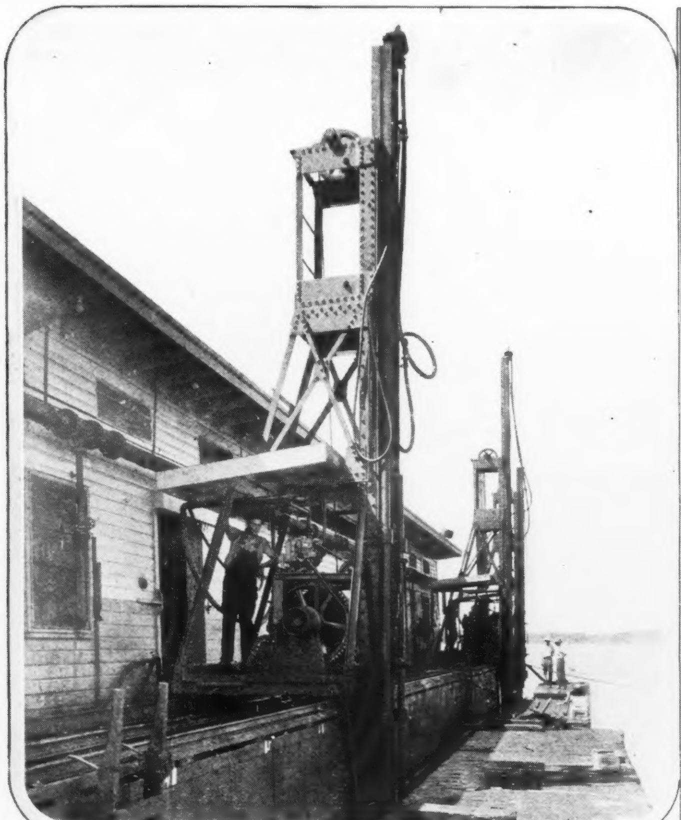
This stretch of the Mississippi is commonly known as the Rock Island Rapids; and in attacking its rock bottom it was impossible for the army engineers to follow the procedure adopted by them in excavating the river bed where rock does not prevail. In the open river the low-water slope averages about 0.4 foot per mile, while the low-water slope throughout the rapids averages 1.4 feet per mile or 20.5 feet for the entire distance. This difference in slope adds to the difficulty confronting both the navigator and the men engaged in improving the channel.

The bottom in this section consists, for the most part, of limestone rock, which lies in the form of ridges or "chains" across the course of the stream; and these chains are above the required grade of 6 feet of water at low water. Through these rock chains have been cut by the action of the water, in time, narrow and tortuous though comparatively deep channels, which had to be followed at low-water stages by boats navigating that stretch of the river. This was always dangerous, and not infrequently impossible, owing to the wind and to the cross currents which tended to thrust the craft against the projecting parts of the rock ledges—often causing them serious damage. This condition rendered navigation impracticable except at reasonably high stages of water; and the situation attracted public attention at an early date.

The first survey, with an eye to the improvement of the Rock Island Rapids, was made by Lieut. N. B. Buford, U. S. A., in 1829. Other surveys followed in 1836, by H. N. Schreve; in 1837, by Lieut. Robert E. Lee and by H. C. Meigs; in 1853, by Lieutenant Warren; and in 1866 and 1867, by Captain Harris and Assistant Hoffman under the direction of Gen. J. H. Wilson, U. S. A. As a result, a comprehensive project for the improvement of the rapids was adopted. This project has been modified from time to time in response to the demands of navigation interests, and has consisted of deepening, widening, and straightening the channel over the seven chains known, respectively, as the Upper or Smiths Chain, and the Sycamore, Saint Louis, Campbells, Duck Creek, Moline, and Lower chains. These chains constituted the only real menace to navigation.

The channel width as now adopted varies from 200 to 250 feet; and the low-water depth in the navigable channel that now obtains over this reach is 6 feet. At some places in this stretch the rocky bed of the river projects out from each shore like a bar—the projecting points sometimes overlapping each

*U. S. Associate Engineer.



Left—"No. 426", showing the three drill frames fitted with X-80 drills. Right—One of the four air operated spud engine installed aboard "No. 426". The spuds serve to anchor the boat in position while drilling.

other and leaving only a narrow, tortuous channel between them. At others, however, the rocky bed extends like a dam or narrow bar across the stream. Between the chains, throughout well-nigh the entire distance, is a wide, deep, and navigable channel, and there the velocity of the current and the slope are much less than on the chains. As a matter of fact, for eleven miles out of the total fourteen there is good navigable water at low stages—the hampering obstructions covering only a little more than three miles.

It will be noted that, because of the nature of the material encountered and the lack of dynamite and modern rock-excavating machinery, the work of deepening the channel in the early days was a very serious, expensive, and slow proposition. The first and only procedure that then naturally suggested itself as being practicable was to build a cofferdam about a given area, to unwater it, and then to use hand drills for putting down the necessary holes. This was done. The holes were loaded with black powder and blasted, and the loosened rock finally removed by carts and teams.

The first cofferdam of which any record is obtainable was constructed in 1868 at Moline Chain; and the reports show that 20,000 cubic yards of rock was taken from the unwatered section. About the same time a cofferdam was built at Sycamore Chain, where 45 acres were unwatered and 18,000 cubic yards of solid rock was removed in the dry. In 1860, bids were submitted for rock excavating as follows: $14 per cubic yard in solid, isolated patches of rock at Smiths Chain, and $8 per cubic yard where the yardage was apparently of greater magnitude.

The first attempt at wet rock excavating was in 1872, when a "chisel boat" was designed and operated for breaking up ledge rock—the shattered rock being subsequently handled by a dipper dredge. This method was fairly effective in getting rid of narrow, high, projecting points; but, naturally, it could not begin to accomplish the desired results—that is, to break down to any extent into a solid, level bottom, such as prevailed at that time throughout most of the chains. The following extract from the Annual Report of the Chief of Engineers, for 1872, contains a good description of the chisel boat:

"The chisel, which was operated after the manner of a pile driver, was constructed of wrought iron, from 12 to 18 feet in length, and from 1 foot to 1 foot 3 inches in thickness. The point was made of cast steel, about 1 foot in length, wedge shaped, and welded to the wrought iron shank. In this shape it was used by the contractors. When this point became dull, and the chisel in consequence ineffective, the whole mass, weighing from 3 to 4 tons, was transported to Chicago to be resharpened, involving great loss of time and great expense, the chisel boat being in the meantime inactive.

"Mr. Whitney substituted a movable steel point, about 3 feet in length and 1 foot in thickness, (the so-called Whitney point) that, when dull, can be quickly removed and another substituted in its place—a supply of about twenty points being kept on hand.

"Mr. Whitney has also more than doubled the strokes per minute by a change of gearing; has improved the head block and the mode of attaching the chisel to the head block; and, in fact, has transformed the chisel into an efficient rock-excavating instrument by means of which patches of rock, of too small extent to justify the construction of a cofferdam, can be removed rapidly and cheaply."

That outfit must have been, for its day, a fine piece of equipment; and, no doubt, it was heralded then as a great achievement.

In 1867, Alfred Nobel overcame tremendous difficulties by giving to the world a usable high explosive, that is, dynamite, which is still serving well the purpose for which it was conceived. Dynamite virtually opened up a new field of development for machinery intended to excavate hard material in the wet or underwater; and it also revolutionized the methods employed in this field of work.

The first "drillboat" to be used on the Rock Island Rapids for excavating rock was built in 1889: and that craft was followed by a similar one, constructed in 1893. A description of the 1889 drillboat is contained in the Annual Report of the Chief of Engineers of 1890, and reads:

"The drillboat employed is a scow, built of pine lumber and fitted with longitudinal hog chains to give sufficient stiffness, 80 feet in length, 22 feet wide, 4 feet hold, and 22 inches draft. A small cabin is fitted with four anchorage spuds, one near each corner, worked by hand by means of cranks and rack and pinion gearing.

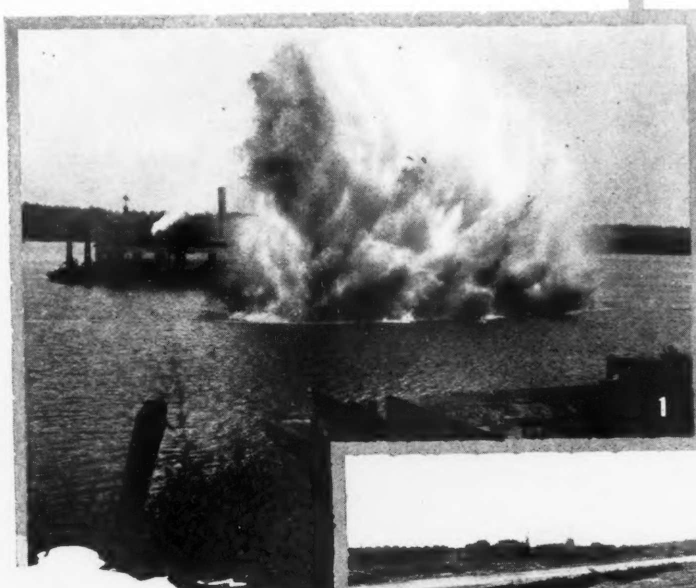
"There are two steam capstans, one near each end, providing the means of readily moving the boat either into place or to avoid a blast or passing raft. There were five anchor lines used, one a substantial head line and four side lines. In shifting position, the spuds were raised clear of the bottom—the boat being held up by the head line and the side lines being utilized for bringing her into any desired position. There are two steam drills running on travelers on one side of the boat so that the boat, hanging by the head line, could be swung across a patch or field of rock and the drills be made to cover a width of 56 feet on a single range. The distance to which the boat was moved when firing a blast was from 20 to 50 feet, according to the amount of explosive used. The latter distance was considered safe even for heavy blasts, although at times stones from 10 to 30 pounds in weight have been thrown a distance of 200 feet.

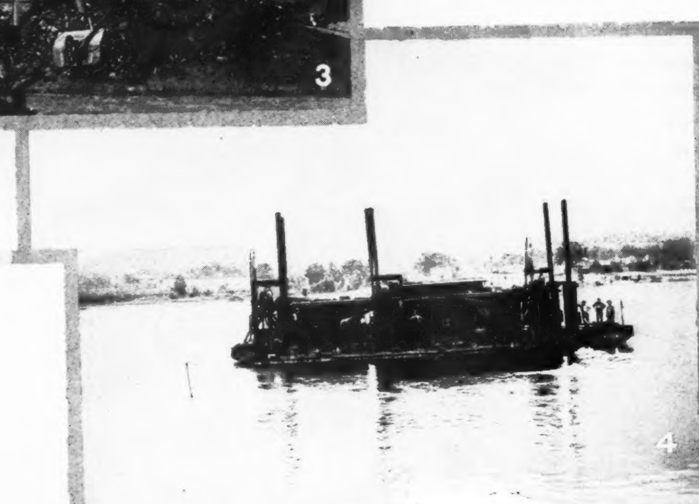
"The drill points were star shaped, $3\frac{1}{2}$ inches across, and made from $1\frac{1}{2}$-inch octagon cast steel. The holes were drilled to a depth of $5\frac{1}{2}$ feet below low water and 4 feet apart, exceptions being made to this interval when it appeared that previous blasts had already shattered the rock, or when the surface was already below grade. After a line of holes had been drilled the loading was proceeded with.

"The explosive used was 'New No. 1' dynamite, containing 50 per cent nitro-glycerine and other explosive ingredients—the cartridge being 2 inches long by $2\frac{1}{2}$ inches in diameter and weighing about $\frac{1}{2}$ pound. The charges were made up of from 2 to 4 cartridges, according to depth of hole and hardness of rock encountered, 1 pound being sufficient for a 30-inch hole in soft rock and $1\frac{1}{2}$ to 2 pounds for deeper holes in harder rock. In the top cartridge of each charge was placed an exploder with 8-foot wires serving to connect all the charges with each other and with the battery wires so as to complete the circuit. In loading, for convenience in handling the charges, etc., a small flatboat, 20 feet long by 6 feet wide, was brought alongside. A copper pipe, 3 inches in diameter and with a continuous slot about $\frac{1}{2}$ inch in width for carrying the exploder wires, was inserted in each hole consecutively. The holes were cleared of sand by slushing out with a pump and water hose; and then the charges were dropped down the tube into the hole and pushed to the bottom with a ramrod. After the wires were properly connected the drillboat was moved away to a safe distance; the leading wires connected with a frictional battery; and the blast fired. It sometimes happened that the connecting wires became detached or that one or more of the exploders were imperfect, resulting in a misfire. Whenever this occurred the boat was swung back into its old position, and the wires were picked up and examined. If found intact, the failure was attributed to the exploders, and another round was made up of a single cartridge and exploder for each hole. A great deal of trouble was met with because of the holes becoming filled with sand, gravel and small rock. When this material could not be washed out, the holes had to be redrilled, which happened quite frequently. It is thought that the drillboat can do twice as much work when sand and gravel do not interfere and in ordinary stratified limestone which does not wear out the drill points so rapidly. The dredge worked over the blasted area removing the broken rock; and when points were found above grade, the drillboat was brought back until at length a careful examination showed the work completed."

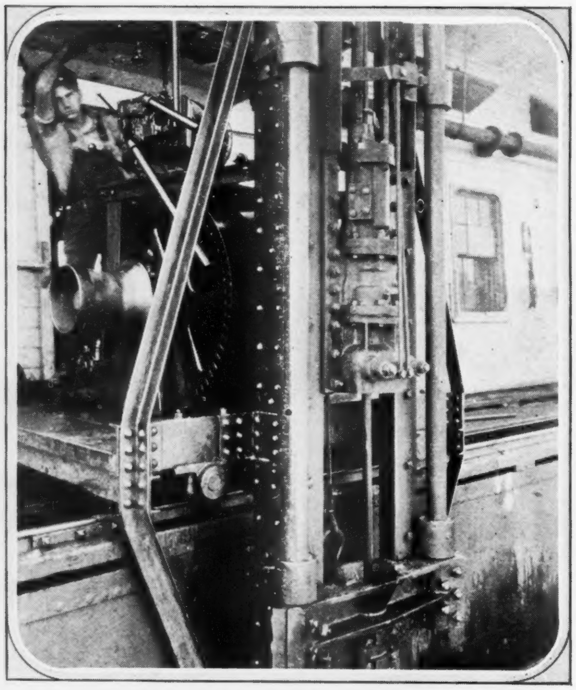
The two boats used today in Moline Pool are much like the craft just described, except that on one of them a third drill has been added. The runway for the drill carriages has been extended so that it is more nearly the length of the hull, and, as a result, a line of holes 72 feet instead of 56 feet long can be covered. The method of handling the vertical travel of the drill is not mentioned in the re-

		Cost Per Cubic Yard
Quota miscellaneous overhead charges	$ 362.35	$ .0504
Superintendence and Office:		
Field superintendence and office	2,623.00	.3648
Quota Rock Island office charges	633.69	.0881
Labor and subsistence	7,221.05	1.0043
Supplies:		
Powder and fuses	4,699.90	.6536
Miscellaneous supplies	764.30	.1063
Coal	1,162.42	.1617
Repairs	666.39	.0927
Towing:		
Labor and subsistence	367.45	.0511
Coal	108.40	.0151
Total	18,608.95	2.5881
Quota plant charges	4,743.43	.6597
Total	**$23,352.38**	**$3.2478**





1—Setting off a blast in rock previously drilled by the vessel in the background. 2—Drillboat "No. 426", equipped with air-driven hammer drills. 3—Removing rock from an unwatered area protected with a cofferdam. 4—One of the older steam-operated Government drillboats. 5—U. S. Engineers dredge "Keokuk" excavating rock drilled by "No. 426".



One of the X-80 drills, showing leads and mud pipe. A 9H "Little Tugger" hoist is mounted above the main hoist.

port, but it was probably the same as that now employed. The ordinary travel of the cylinder casting in the back casting or shell is about 24 inches and is controlled by a hand-worked feed screw, such as seen on a tripod drill. In addition, a vertical lift of 6 feet is obtained by a feed screw, in the carriage leads, operating through a yoke that slides on rails attached to the leads—the yoke being secured to the back shell of the drill. This gives a total vertical lift of 8 feet, which is ample for the depth of holes drilled.

The drilling machines have a 4¼-inch piston with an 8-inch stroke, and the rotating motion of the chuck, which holds the drill bit, is provided for by a rifled piston rod and ratchet. Steam power is used; and the steam is carried to the machine by a hose connection with a main running from the boiler and along the cabin wall. After a patch or small area has been drilled and blasted, the resulting loose rock is removed with a dipper dredge or by a derrick boat operating a 2-cubic-yard clam-shell bucket—the material being loaded on barges and unloaded as spoils or, in some cases, utilized in building dams and shore protections.

During the season of 1910, one drillboat using two drills only, was at work in Moline Pool, and the cost of blasting 7,190.3 cubic yards of rock is shown in the accompanying table.

The plant charge shown is not a money transaction from the allotment for this division. It is a quota of the total sum spent during the year for new plant and for winter repairs to old plant, and is based on an assumed rental value for the actual number of days the boat was in service.

The reduction in the cost of breaking rock by the use of the drillboat instead of by the chisel boat was approximately 66⅔ per cent, based on calculations made by the engineer in charge of the work at the end of the season of 1878. The older drillboats were still in commission in 1911, and then boasted a few added improvements. As far as their drilling machinery was concerned, they were both equipped throughout with Ingersoll-Rand products. In 1912, they were condemned and replaced by drillboat *No. 426*.

Drillboat *No. 426* has a steel hull 132 feet long, 32 feet wide, and 6 feet deep. It was first equipped with four Type H-64 Ingersoll-Rand drills, which have a piston diameter of 5½ inches and a stroke of 8 inches. The drill slab was operated by a 6⅛x7-inch double-cylinder hoist engine on a carriage; and the drill made 450 strokes a minute. The steel used was 2 inches in diameter and varied from 14 to 20 feet in length. The diameter of the bit was 3½ inches. The spud, capstan, and handling arrangements were very similar to those on the old drillboats previously described.

In 1927 the four steam drills were replaced by three air-operated X-80 drills, and the steam plant gave way to a group of four compressors direct connected to four Ingersoll-Rand, solid-injection, 4-cycle, POV-2 Diesel engines—the compressors furnishing air for the rock drills, a drill-steel sharpener, the spud hoists, and the capstans. Each unit is capable of supplying the equivalent of 354 cubic feet of air per minute. The plant was chosen because it would assure continuity of service at low operating cost in combination with freedom from vibration and moderate floor-space requirements. Four units make it practicable to distribute the weight on the drillboat's deck and to insure operating flexibility. Furthermore, they provide a reserve of power should any one of the oil-engine compressors be momentarily idle for one reason or another. One compressor serves each of the three drills, and the fourth POV-2 furnishes air for the capstans, the spud-hoist engines, the forge, and the No. 50 "Leyner" sharpener.

Since the installation of the air equipment, the boat has been continuously employed on small "patch" drilling requiring only shallow holes. This work necessitates the frequent moving of the drillboat; and up to date it has not been possible, therefore, to arrive at an accurate comparison between steam- and air-operated drills. Even so, it may be stated positively that the air-driven X-80 drills will put down a hole at the rate of 1 foot per minute, while the old drills took 5 minutes to put a hole down to a depth of 1 foot.

One great and noticeable advantage stands out in favor of the new equipment. There are no hot pipes to be handled; and there is no escaping steam to be continually dodged by the crew in order to avoid being scalded. Apart from the foregoing gains, the major reason for the choice of the oil-engine compressor is an economic one. Just as drilling costs are lowered by the use of air-operated drills instead of steam drills, so does the substitution of the oil engine insure savings that are not practicable when steam is employed. In brief, the new equipment effects economies in two directions. This conclusion is based upon two things: The excellent performance of the units since they have been in service, and 25 years of experience with other products turned out by the same well-known company.

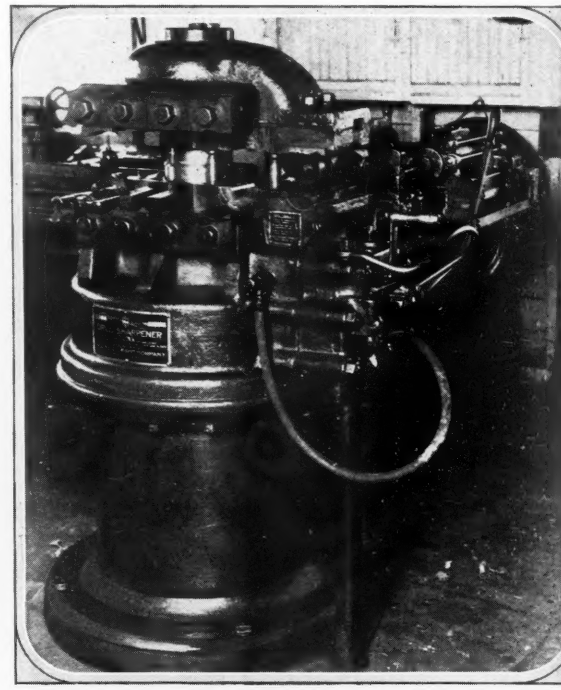
The preceding description of the various methods used during the last 60 years in breaking up rock in the Mississippi River shows a remarkable contrast both in the pro-

Sounding the river bottom for drillboat locations.

cedures and in the types of equipment employed by the engineers at different periods. We see how, step by step, progress in the art has been made. First, cofferdams were built and the confined area of the river bed unwatered; next came the chisel boat, which can be classed as a forerunner of the more modern Lobnitz breaker; after that appeared the drillboat equipped with steam-driven rock drills; and now we have a craft provided with modern hammer drills operated with compressed air—the compressors being driven by oil engines.

It is scarcely likely that anyone, except those who have had charge of river and harbor rock-excavating projects, could appreciate the extreme difficulties encountered in this sort of work. Ordinary rock-drilling jobs, when they are not deep under the water, are bad enough; but when the rock is submerged from 30 to 40 feet—as frequently happens in our seaports where channel improvements are required, and where strong tidal currents, the swell and surge of passing vessels, and the sweep of winds add to the troubles and to the dangers—then the work becomes both trying and hard. To operate drills from a vessel 30 or 40 feet above the rock, itself, and to hold the drillboat in a fixed position in relation to the rock under the conditions mentioned, are not easy tasks. It should be obvious that the craft must be held immovable in relation to the hole being drilled.

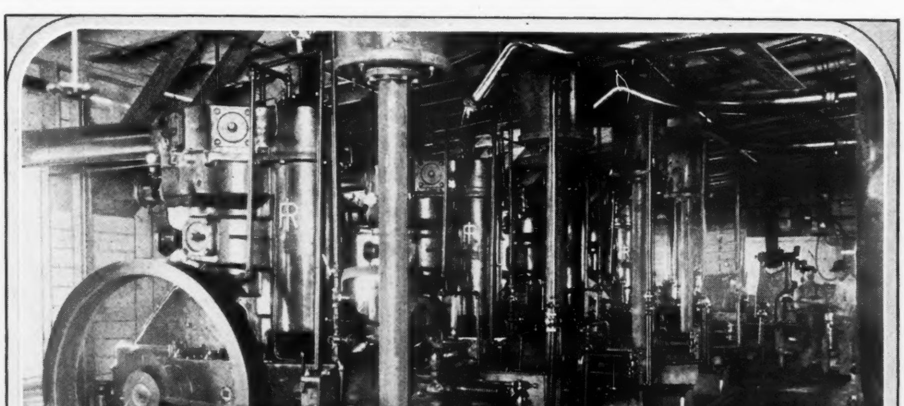
It has been the general and standard practice for many years to use the steam-operated piston drill with solid steel long enough to reach from the deck of the boat down to the bottom of the hole. This type of equipment and this method of drilling have necessitated the employment of drill steels ranging from 2 inches to 3½ inches in diameter and from 50 to 60 feet in length. A long piece of steel weighing about 600 pounds—in extreme cases as much as 1,500 or 1,600 pounds—is exceedingly awkward to handle. Furthermore, such a steel is equally awkward to detach from the drill; and it is at all times cumbersome. When drilling in hard rock, a steel of this kind has to be removed from the drill for resharpening every hour or so; and it is a very unhandy thing for the blacksmith to manipulate when redressing it. When a solid steel is used in a piston drill, a wash pipe must be employed to clear the mud and the cuttings out of the hole—the drill being stopped and the steel withdrawn part way in order to facilitate this operation.



All drill steels used on the U. S. "No. 426" are dressed in a No. 50 "Leyner" sharpener.

In striking contrast to the foregoing is the modern air-driven hammer drill, which has been designed and developed to obviate the use of decidedly long and heavy steels. These new drills, on drillboat *No. 426*, are operated much the same as the familiar piston drill, except with one radical innovation—that is, the drilling machine, itself, works completely submerged and comparatively close to the bottom. This arrangement makes it practicable to employ a drill steel approximately 20 feet in length—depending, of course, upon the depth of the hole to be put down. In other words, the drill steel need be only long enough to reach from a position just above the harbor bed to the bottom of the hole to be drilled.

The steel utilized is hollow and about 1½ inches in diameter; and a 20-foot piece will weigh something like 120 pounds. No bolts are required for chucking—the steel being provided with a "Leyner" shank. To secure a steel in place it is necessary only to insert it in the drill chuck and to rotate it slightly when in position. This makes the changing of a drill steel a simple and a quick operation—in fact, a dull steel can be withdrawn from a hole and another one substituted in the brief period of five minutes. This is not more than one-tenth of the time taken to insert a heavy steel in the chuck of a piston drill. By forcing a jet of water through the hollow steel, thus washing away the cuttings from the bottom of the hole, it is possible not only to increase the drilling speed but to do away with the use of the troublesome wash pipe. A blacksmith with a helper can readily handle all the steels needed for the air-driven hammer drills; and the bits can be quickly sharpened by the "Leyner" drill-steel sharpener with which the boat is equipped. Such a sharpener insures an abundance of symmetrical and properly formed bits at all times.



These four POV-2 Ingersoll-Rand oil-engine compressors furnish air for various services aboard the drillboat.

With the X-80's on drillboat *No. 426* it is feasible to accomplish three times as much work, to drill three times the number of holes, as with the piston drills formerly aboard vessels of this type. Likewise, there is a striking contrast between the drills when operating: in the case of those on the *No. 426* the noise is almost eliminated. As the drills are completely submerged, virtually the only evidence of their working is the bubbles of exhaust air that rise to the surface of the water.

Just as radical an improvement in its way is the new power plant. When drills are run by steam, the boilers must be supplied with coal and fresh water—fresh water being indispensable when operating on the sea coast. Drillboat *No. 426*, with her oil-engine compressors, can easily carry a month's supply of fuel oil, thus greatly reducing the cost of attendance and of fuel. The all-around efficiency of the boat's present equipment assures a big saving in the cost of drilling operations.

The writer wishes to acknowledge his indebtedness to Maj. C. L. Hall, Corps of Engineers, for permission to consult Government records and to use certain official prints in this article.

Quarry Safety Award Closely Contested

THE National Safety Competition for 1927 has been won by the White Haven Quarry of the General Crushed Stone Company after a keen contest with two other quarries. Figures compiled by the United States Bureau of Mines disclosed that three quarries, entered in the National Safety Competition, had succeeded in making splendid safety records for themselves. In short, their 1927 operations were not marred by a single lost-time accident!

Magazine in which are stored the explosives used in the White Haven Quarry of the General Crushed Stone Company.

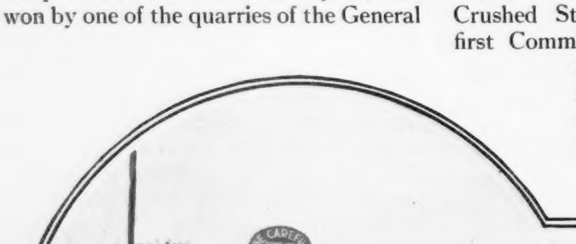
In view of this situation it was decided to give the palm to the quarry that had to its credit the greatest number of man-hours of labor, that is, where the chance of accident was greatest. Therefore, the trophy was awarded to the White Haven sandstone quarry, at White Haven, Pa., which had put in 310 working days, or 159,320 man-hours, in twelve months without a lost-time accident. This was 157 days or 5,233 man-hours more than its nearest competitor, the Louisville Cement Company's rock quarry at Speed Ind.

Much enthusiasm was aroused in the industry when it was announced that the coveted plaque, presented annually by *The Explosives Engineer* to the member of the National Crushed Stone Association having the best accident-prevention record for the year, had been won by one of the quarries of the General Crushed Stone Company. That company is a firm believer in teaching "safety first"; and as a part of its regular working schedule has introduced a system of education for the purpose of safeguarding its employees. At the White Haven plant, the safety committee consists of five members, namely, P. H. Jacoby, superintendent of the quarry, Elmer P. Wheeler, John J. Park, William Schaffer, Jr., John Bensch, and Edward Kulp. These men deserve much credit for the splendid showing made; and in their efforts to protect life and limb they have the whole-hearted support of John Rice, president of the General Crushed Stone Company, and Otho M. Graves, vice-president and general manager.

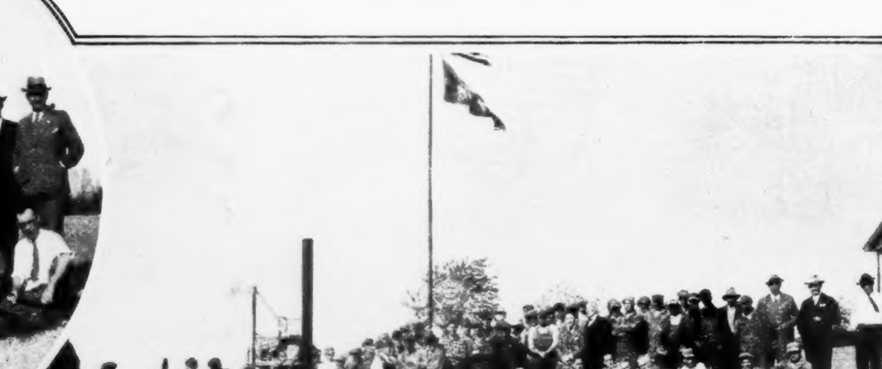
Mr. Graves, as president of the National Crushed Stone Association, appointed the first Committee on Welfare and Safety to function as a part of the association—the purpose of the committee being to investigate conditions in the industry the country over and to make recommendations with a view to introducing safer methods for any and all hazardous procedures. It is the practice of the committee to meet whenever necessary to discuss such problems as may arise and to review the accident-prevention work already done.

The awarding of the trophy late last year by N. S. Greensfelder, editor of *The Explosives Engineer*, was made the occasion of an impressive ceremony at the White Haven Quarry. In presenting the plaque to P. H. Jacoby, Mr. Greensfelder congratulated the winners on their remarkable safety record and stressed the value of organized safety education. Next, Mr. Rice spoke on the humanitarian and the economic standpoints of the question. He brought out the facts that, as a result of what has so far been achieved, insurance rates have been lowered and expenditures for workmen's compensation and accident benefits measurably reduced. Brief addresses were also made by Mr. Graves, H. F. Yotter, insurance supervisor of the General Crushed Stone Company; and T. J. Quigley, chief of the Bureau of Pits and Quarries of the Commonwealth of Pennsylvania.

Following numerous satisfactory tests, a Bremen shipyard is going to use steel plates containing 0.28 per cent copper in the construction of two vessels. It is claimed that the higher cost of these plates will be offset by their increased resistance to corrosion—thus giving them longer life.



Safety committees. Members of the general committee are standing while those of the plant committee are sitting.



Presentation of the plaque: P. H. Jacoby receiving the token from N. S. Greensfelder.

Marked Traffic Lanes Assure Safer Travel

"STAY on your own side of the road", is the message conveyed to the motorist by the painted center line now so often found on certain stretches of busy highways; and the motorist has learned that it is expedient for him to heed this warning. It is an accepted fact that these lines of demarcation have contributed much to the safety of automobile travel by preventing head-on collisions, especially at sharp curves where a driver otherwise is apt to trespass on the opposing traffic lane.

In the State of California this system of marking has proved so effective that it is now being widely employed not only at intersections, on blind curves, and on narrow bridges, as was the practice in the past, but also on winding roads in mountainous country and on 4-lane trunk highways. By plainly indicating the several traffic lanes on these wide, level roads, it is possible to keep the slower-moving vehicles in the outer lanes, leaving the inner ones for high-speed cars.

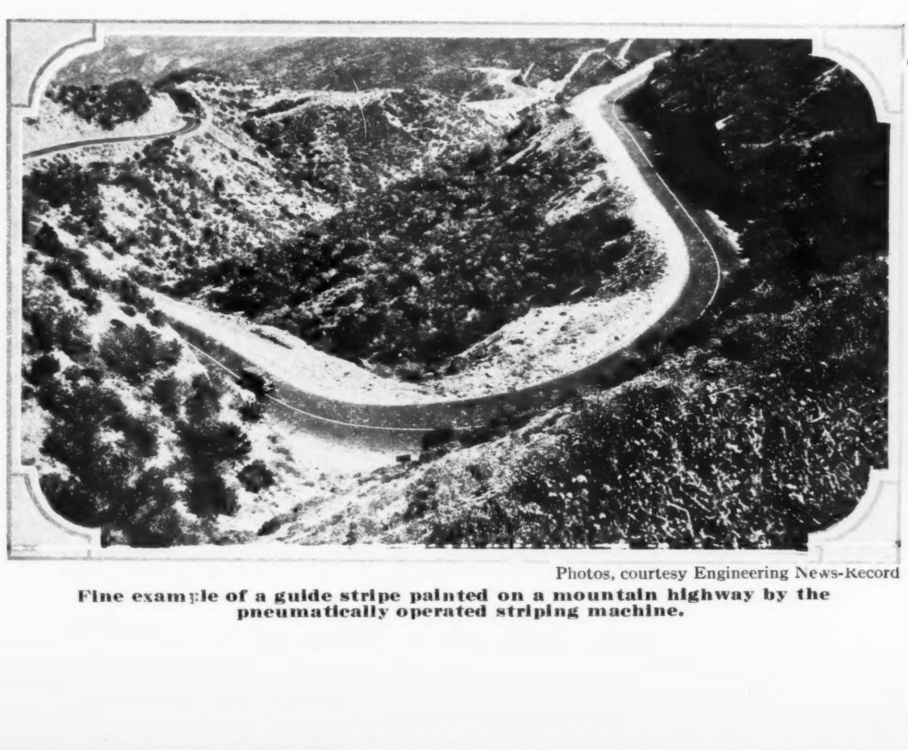
This highway striping machine uses compressed air to spray the paint.

A broad stripe of bright hue along either side of a pavement with oiled shoulders likewise is of great assistance at night, particularly where fog is prevalent and in desert regions where it is difficult under normal conditions to distinguish the edges and, therefore, to maintain a safe average speed. So far, more than 260 miles of that state's highways have been improved in this manner, and the mileage is being steadily increased.

For this work, the maintenance department of the California Division of Highways has tried various makes of striping machines, some of their own contriving. The one now most extensively employed applies the paint by means of compressed air, and is the product of the Simons Paint Spray Brush Company. This apparatus, which is shown in one of the accompanying photographs, consists principally of a compressor, a small gasoline engine, and a 20-gallon tank. It works in conjunction with a motor truck, on which are carried a reserve supply of paint and other necessary materials and equipment. The striping machine, itself, is pushed by hand—a guide wheel in front helping the operator to follow the line previously placed there for him either by a wheel device with a marker arm if the edge of the pavement be even or, if that be not the case, by the aid of a cable, the position of which is determined by measurements. The resulting stripe is well-defined—ragged edges or spattering being avoided by two vertical plates that serve to keep the paint within prescribed limits after leaving the spray nozzle.

Obviously, a fast-drying paint is best suited for this purpose. It is also necessary that it be applied quickly; that it be distributed uniformly; and that it wear well under service conditions. In the beginning a white stripe was generally favored; but now, in California at least, it has given way to one of bright orange—commercial grades of a special lacquer paint being used. Although the paint is sufficiently dry to bear traffic in from 45 minutes to two hours, depending, of course, on the state of the weather, it is customary to place stones or "keep-off" signs along the freshly made stripe—the truck crew removing them at the end of the day's work.

According to data furnished by the California Division of Highways, it takes anywhere from 10 to 15 gallons to paint a stripe 6 inches wide—now the standard in that state—and a mile long; and the cost per mile, as now applied, averages about $38.



Photos, courtesy Engineering News-Record

Fine example of a guide stripe painted on a mountain highway by the pneumatically operated striping machine.

MOTOR FUEL FROM COAL

ACTIVE investigations to develop primary and secondary sources of motor fuel against a possible future decline in petroleum production are going forward steadily with noteworthy success, reports the United States Bureau of Mines.

The Bergius process for the hydrogenation and the liquefaction of coal transforms coal into a crude low-grade oil from which gasoline, kerosene, Diesel engine fuel oil, and pitch are obtained by the use of further refining methods akin to those employed in the petroleum industry. Parallel developments have taken place in the conversion of coal into gasoline substitutes by catalysis, and in the complete gasification of coal or coke—the gas being subsequently turned into alcohol or hydrocarbons. The Bergius process gives a yield per short ton of typical gas-flame coal of 6 per cent ash of 140 United States gallons of refined products made up of 48 gallons of motor fuel, 54 gallons of Diesel engine and creosote oils, 16 gallons of lubricating oil, and 22 gallons of fuel oil.

Several companies in the United States are now manufacturing methanol from coal on a commercial scale for domestic use in the production of solvents and chemicals. Although methanol is inferior to gasoline as a motor fuel, it can apparently be used for that purpose. It is predicted that the next five or ten years will show much advance both in the direct hydrogenation of coal and in the hydrogenation of carbon monoxide.

Montecito County Water Development

By E. M. LILLIE

THE development of a water-supply system in the Santa Barbara district was started during the time the Santa Barbara Mission was being established by the Franciscan fathers, who utilized the waters from the hills and near-by streams to fill their wants as well as those of the Indians and the Spaniards living in that vicinity. Ditches and reservoirs of the old irrigating system are still in evidence in and about the region.

The City of Santa Barbara grew up around the mission; and later came the exclusive Montecito district with its winter and summer homes built largely by capitalists who have gone there to enjoy the wonderful climate and scenery of the locality. This distinctly residential district is on the hills adjacent to and overlooking beautiful Santa Barbara, which is situated on the waterfront. The estates for the most part cover extensive acreages; and large volumes of water are required to keep these grounds and private parks in good condition. This problem of irrigation was a serious one until a bond issue was voted on and the development of a water-supply system begun.

Extreme difficulties were encountered when drilling water-bearing strata.

In August of 1924 a tunnel was started in the region back of the Montecito district. Until compressed-air equipment could be made available drilling was done by hand and the work carried on in two shifts a day. Thereafter the heading of the tunnel was advanced rapidly by the aid of DCRW-23 "Jackhamers" and three shifts. The tunnel was holed through on April 18, 1928. It is 7x9 feet in cross section and has a total length of 11,376 feet.

In November of 1924, after considerable progress had been made, water was struck, and the flow gradually increased in volume until it reached a maximum discharge of 9 second-feet. The present flow is about 3 second-feet. Drilling became very difficult after the water-bearing formation was encountered. Many holes were drilled with the water coming out of them with such force that it was impossible to change drill steels or to load them for blasting. The track for the muck cars was laid on timbers so as to permit the water to flow without interfering with those tunneling operations.

Towards the end of the job N-72 "Leyner" drifters were put in service; and it is believed that a record was made at this stage of the work in driving the heading. Mr. F. E. Evans, tunnel superintendent, advanced the heading 521 feet in one month, using only one N-72 drill. Mucking was done by hand methods. A No. 4 "Leyner" drill-steel sharpener was employed to keep the bits in perfect condition as well as to make up new steels and to repair broken steels. Lunches were served to the miners in the tunnel. The electric locomotive hauling the cars was timed so as to arrive at the lunch hour; and a hot meal was welcomed by all the underground workers.

In addition to this long tunnel a shorter one is to be driven. This second tunnel will be 1,000 feet long, and will give access to another reservoir site in a canyon beyond. The new reservoir will be known as the Juncal, and will have a capacity of 6,400 acre-feet. Material and supplies for the Juncal Reservoir will be transported from the main tunnel over a 2½-mile, narrow-gage track.

The Buell Dam, which has just been finished, is a hydraulic-fill dam. It has called for an earth fill of 143,000 cubic yards, and has a capacity of 60,000,000 gallons of water. The face of the dam was concreted and finished with a coating of gunite. Air for this work was furnished by a 12x10-inch ER-1 compressor.

After the conclusion of this part of the project in the distant hills it was necessary to build a complete distributing system consisting of 35 miles of cast-iron piping and 10 miles of steel, welded pipe. Hard soil and boulders were encountered during the pipe-laying operations; and to deal with them a 7x6-inch Ingersoll-Rand portable compressor and pneumatic paving breakers and clay diggers were employed to speed up the work.

The main tunnel will be lined with concrete; and it will then be used in transporting men and materials to the other side of the mountain, where the next phase of the system will be undertaken.

Left—Downstream slope of the Buell Dam planted with seedling evergreens. Right—Facing the upstream slope of the dam with reinforced-concrete slabs.

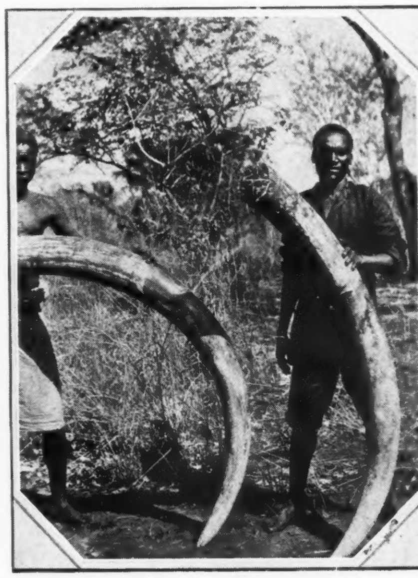
Kongo Cameos

Some Characters and Ceremonies Observed in "Cannibal Land" During a Recent Visit

By OWEN LETCHER

WAY up in the southern portion of the heart of Africa, 2,300 miles north of Table Bay and the Mother City of the South, is a little town which must be regarded as the most remarkable habitation of man on the face of the African continent. It is known as Elisabethville, named so in honor of the queen of the Belgians who, with the king, has recently been visiting the Kongo, of which Elisabethville is the largest town. Thirty-seven years ago there was a race between King Leopold II and Cecil John Rhodes for possession of those few hundreds of thousands of square miles of African soil which are today included within the Katanga Province, of which Elisabethville is the capital. In those days all that vast territory was a sort of no man's land—a land of vague suzerainties and despotic black potentates. There were some dramatic happenings in that country in 1891. But, in the long run, Leopold II—sponsor of the Kongo Free State—won; and the *drapeau bleu comme l'etoile d'or*, the flag of the Kongo Free State, was hoisted over the Katanga, which has since proved itself to contain one of the richest mineral belts in the world.

It was an American citizen who was mainly responsible for the opening up of the Kongo basin and for securing the influential sponsorship of the most astute monarch of Europe in the development of this great state—the very core and heart of Africa. That man was Henry Morton Stanley. Stanley's real name was John Rowland, and he was born in Denbighshire, Wales. The immensity of the development which King Leopold and Stanley between them initiated is only now beginning to be appreciated. A week or two ago I stood in front of the cathedral at Elisabethville



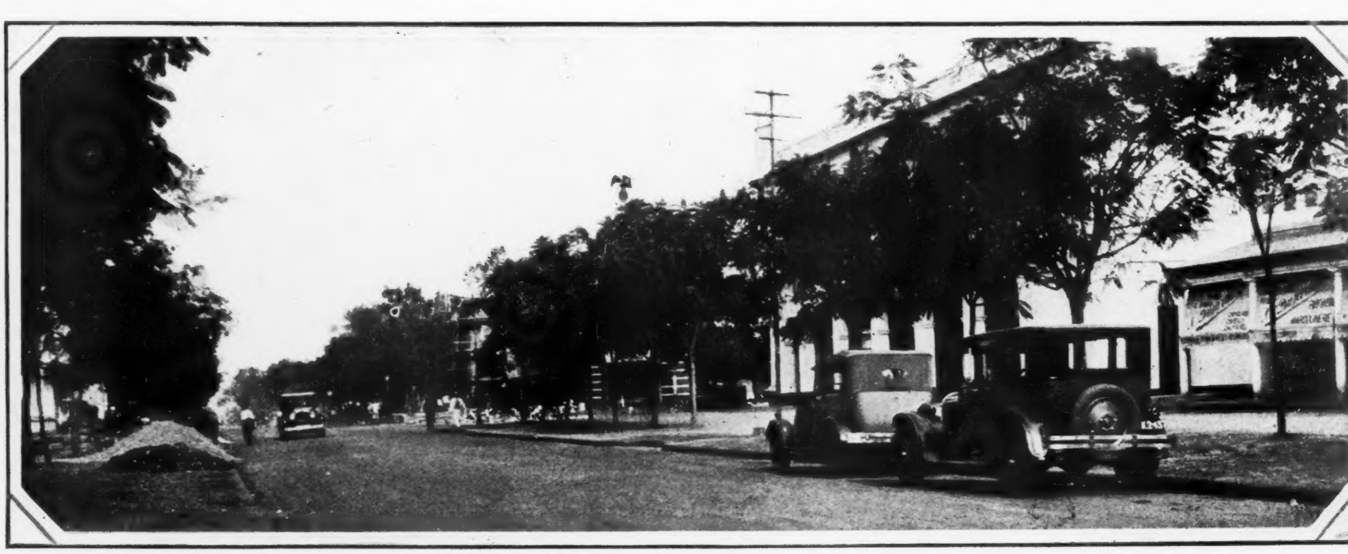
Fine pair of tusks from an elephant shot by the author.

and watched the *askari*—black soldiers—present arms whilst the native band played *La Brabaconne*, the national anthem of Belgium. Governor Heenen and his staff stood at attention alongside a big Minerva car specially imported from Belgium for the royal visit. From the tower of the cathedral the red, gold, and black of Belgium fluttered listlessly in the African breeze; and the sun beat down from an azure sky on a scene of variegated vivacity. The occasion was the commemoration of the forty-third anniversary of the founding of the Kongo Free State.

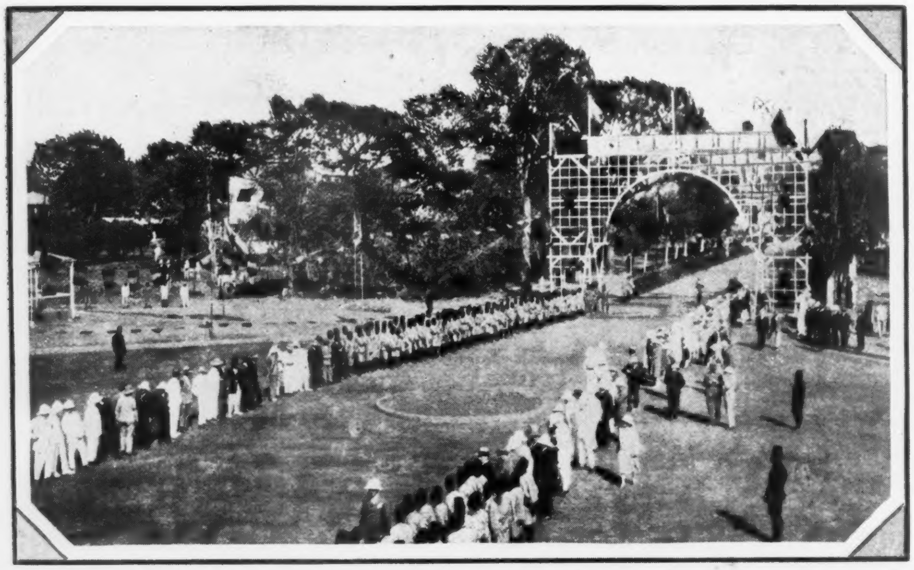
The scene on the square fronting Elisabethville's red-brick cathedral on that Sunday morning was a memorable one; and as I watched it I could not help recalling the adventurous tales of Stanley's journeyings that thrilled one as a boy, and the pictures of "Darkest Africa" with Kongo river boats being attacked by savage tribes. Such was the vision of barbarism that not so very long ago arose in the minds of most people when they heard the mystic word Kongo pronounced. And as a matter of fact that is still the conception of many. There remain, of course, immense stretches of almost virgin and unexplored equatorial forest. There are backwaters of the Kongo and of its tributaries that have not yet heard any more civilized sound than the splash of a native paddle. There are in this vast country high mountain ranges that are still the homes of the gorilla and of primeval, untutored man.

But under the industrious leadership of the Belgians, the Kongo is being far more rapidly opened up than the world imagines. Those who have not seen all the remarkable development that is going on in Katanga would be astonished if they could view Elisabethville's new *Au Bon Marché* with its night signs faintly reminiscent of New York City's "Great White Way"; the attractiveness of the layout of the tree-flanked boulevards; the magnitude of the Union Minière's establishments at Lubumbashi and Panda; and the number of automobiles that were parked in the Place Royale one Saturday night during a banquet given in honor of the governor. And the many generally well-informed persons who still believe the Kongo to be merely peopled by cannibals would have surveyed with amazement the celebration staged in honor of the state's forty-third anniversary.

That imposing function, held in July of 1928, commemorated the most important



This broad thoroughfare in Elisabethville, in the Belgian Kongo, gives a good idea of the up-to-dateness of the town.



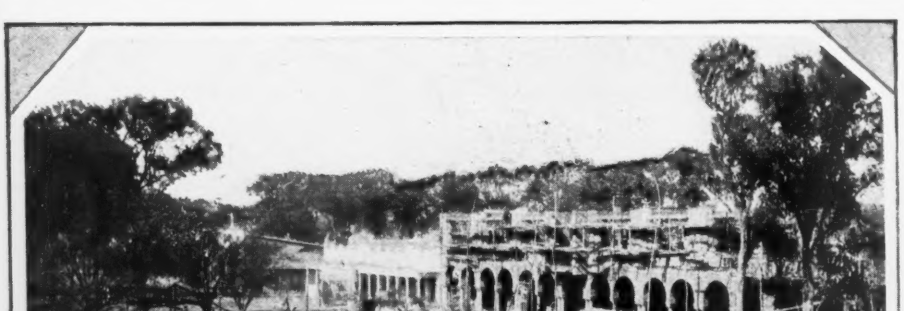
Triumphal arch at the Elisabethville station erected in honor of the king and the queen of Belgium.

date in the history of the country. It was on July 1, 1885, that the basin of the Kongo River was proclaimed an independent state, and thus was founded the constitutional childhood of a territory which is proving itself to be one of the richest regions of the African Continent. Prior to the formal establishment of the independent state, many of the great nineteenth century classical journeys of exploration had been carried out in the basin of the Kongo and in the vicinity of the great lakes to the eastward. In the three decades just prior to the proclamation of the Free State, explorers of numerous nations—for the most part Britishers, Americans, Belgians, French, Germans, and Portuguese—had traversed much of the mysterious heart of Africa and had partially filled in the unmapped gaps. The holding of an international conference at Berlin preceded the passing of the *Act General*; and just twoscore and three years ago the Kongo basin entered upon the status of an independent state.

In contemplating the heroic exploration of this portion of Africa, and in considering the tasks of organizing and of financing the expeditions and, subsequently, an official force to occupy and to exploit the country, two commanding figures stand out head and shoulders above all others—King Leopold and Henry Morton Stanley. These two men had their critics, of course; but the work they achieved was colossal. The obstacles they surmounted were immense; and the reward which their labors were eventually to secure—it has come too late for them to realize it—is as magnificent as was their toil. What a changed country is the Kongo of today by comparison with the Kongo of 40 years ago!

Now, one may in two days, by means of an established aeroplane service, make a journey that previously could only be completed in a month or six weeks. The aerial tourist, flying over seas of forest, if he possess a spark of imagination, cannot but ponder on the tremendous changes that have come about in Central Africa since the days when Stanley and others literally fought their way up the Kongo River and hacked paths through virgin forests. It is only mete and fitting that the memory of Stanley and all the mighty work that he accomplished should be perpetuated: and, to do him honor, a set of commemorative stamps have been issued by the Belgian Government. They bear a portrait of the great explorer. It is only fitting, too, that the memory of that astute and far-seeing monarch, King Leopold II, who sponsored Stanley and founded for the Belgian peoples this great colonial possession, should be made enduring by the great Mukwene memorial, which is to be built on the mountain outside Elisabethville.

Arrival of the king and queen. The king is the tall man at the left.



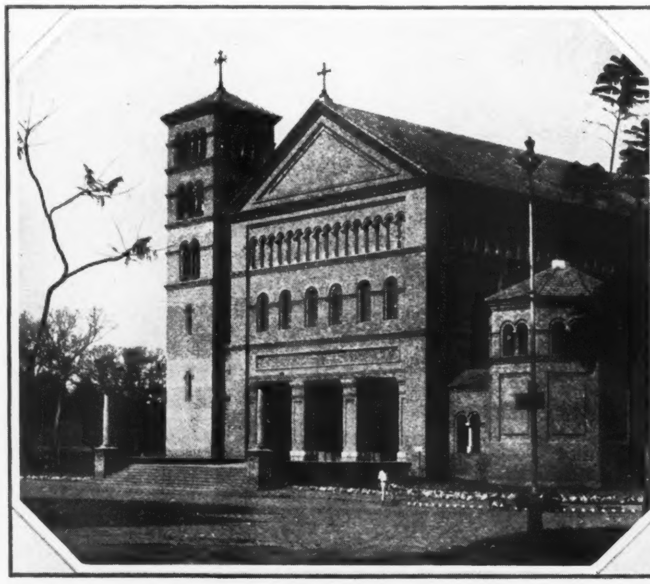
Native troops passing the Standard Bank.

Elisabethville, with its smelter works at Lubumbashi, and the twin towns of Panda-Likasi, where the Union Minière has its big concentrator plant 100 miles away to the northward, are growing and advancing with such strides that old-timers cannot but survey the huge new buildings, the streams of motor traffic, and the brilliant blazes of electric

lights with intense amazement. They must often ask themselves whether this is indeed the Kongo—the country that used to signify cannibals, slave raiders, wild beasts, and the terrible diseases of the African tropics.

Though they are rapidly thinning out, there are still a goodly few of the old-timers left. These men, taking in the sights of the main street of cosmopolitan Likasi, with its rows of shops bearing for the greater part Greek or Italian names, will tell you that not so many years ago they shot lions close to where that Graham truck is now unloading native goods into a large store. I met one or two of these pioneers a few weeks ago. There was "Boetie" Adams, who once was known as the Admiral of the Kafue River because he used to operate boats on that Central African waterway. Boetie has a wonderful fund of reminiscences concerning African travelers, Belgian "big noises", and all the heterogeneous humans who wander through the "Dark Continent". There was another curious character in Likasi, an American dentist of the old school, a long, tall, cadaverous man with a huge black-felt sombrero who looked for all the world like a page out of a novel by Zane Grey. His equipment consisted of a few rusty implements which he carried around in his pocket in a sardine tin; and if anyone had told me that he extracted teeth by means of a lasso or lariat I should hardly have been inclined to argue with him.

One of the most interesting of all Kongo celebrities is the veteran Commandant Lothaire, who traveled out on the *Thysville* with the king and queen and accompanied them on their royal tour of the Kongo during June and July of last year. Lothaire was largely instrumental in breaking the regime of the slave raiders under Tippoo Tib in the Province Oriental of the Kongo between 30 and 40 years ago. It was Lothaire who founded the post at Kilo, in the "nineties". Kilo has since then become the main center of a gold field which is employing 200 Europeans and 19,000 natives; is operating Chilean mills of Nissen stamps; and is producing gold to the value of approximately $2,500,000 per annum. This auriferous region, which contains both reef and alluvial, is located to the west of Lake Albert.

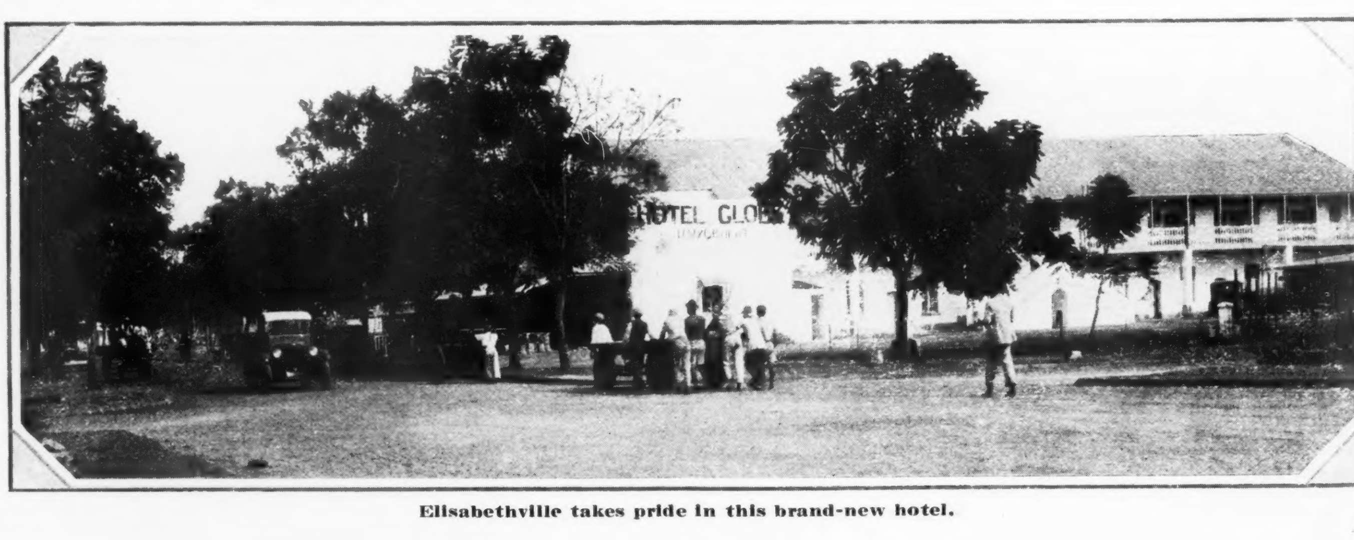


This imposing building is the cathedral, a conspicuous architectural feature of Elisabethville.

During the royal visit, Elisabethville was at its top notch. The streets were gay with flags and draped bunting. Hotels were full of visitors: journalists from all parts of Europe and trippers from every corner of South Africa had arrived in the capital of Katanga. Two football teams from Broken Hill in Northern Rhodesia had come up to do battle with the redoubtable *Belge*. There was an Australian circus and menagerie with Indian elephants, as well as African lions back in their native haunts but behind bars; and merry-go-rounds, swings, shooting galleries, and coconut "shies" galore were doing a roaring trade. At night the Place Royale was a blaze of light. Buicks, Fiats, Minervas, "Chevs," and Fabrique Nationals lined the streets. The governor's palace, on the Boulevard Elisabeth, which looks out over the bushlands to the Lubumbashi copper smelters and to the blue hills of Mukwene, was buzzing with officials in white, bemedaled uniforms. One night, in the Cercle Albert, the Bas Congo-Katanga Railway Company entertained their majesties at dinner; and the banquet was the most brilliant affair I have ever attended in Africa. Public and private dances were in progress, champagne flowed, women in gorgeous evening gowns flitted round the precincts of the Cercle. Thousands of natives had congregated to join in the shouts of welcome—"*Vive le roi! Vive la reine!*" It was an indescribable scene, and one entirely non-African save for the black features of *les indigènes* and that wonderful clear sky which is nowhere to be found except in Africa during the dry or winter months. And yet, while all this was in progress, a lion—an old mangy beast—was prowling around trying to snatch cattle only four miles from the center of the town.

A wonderful country this, the Belgian Kongo, an immense country twice as big as the Union of South Africa. A country of unbounded mineral riches and of vast agricultural and tropical-produce wealth. A land with all grades of climates from the cool drizzle of the Ruanda-Urundi highlands to the scorching heat and tropic deluges of the lower river. A land with enormous labor resources; long and efficiently operated lines of communication by rail, river, and lake, by aeroplane, and by motor car. A land into which capital is being poured by industrious little Belgium. The Kongo's natural resources are so great, and the manner in which the territory is being developed is so thorough, that he would indeed be a bold man who would attempt to set a limit to what may be achieved there in the next ten or fifteen years.

Over and above all the natural advantages which the Kongo possesses, there is this dominant and outstanding fact: the state is free of politicians. It is run as a sort of colonial



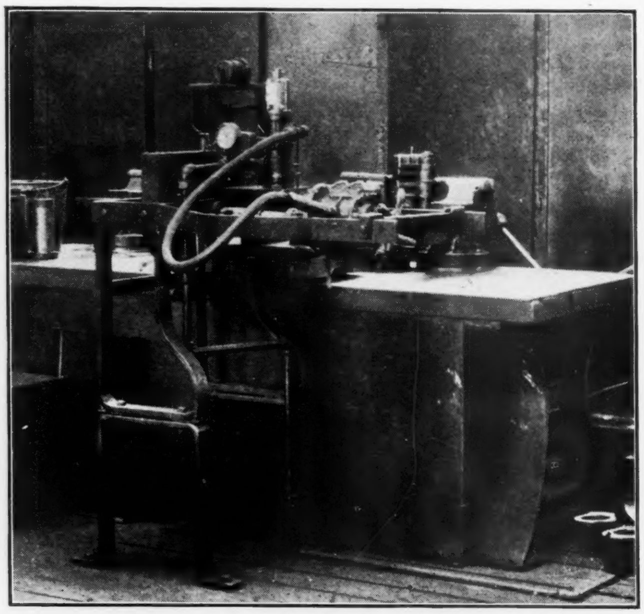
Elisabethville takes pride in this brand-new hotel.

benevolent despotism from Belgium. There are no loud-mouthed party orators to create mischief. The men who are governing the country are workers, not talkers. They have not got to fight for new railways or for other enterprises through legislatures: there is no necessity to buy votes from the proletariat through the medium of professional parliamentarians. And that is perhaps the chief reason why the Kongo is forging ahead with such astonishing rapidity today. That it will advance still more quickly in the next few years cannot be doubted for a single instant. My own idea is that the development which will take place there during the next decade will astonish the whole world.

The State of Sao Paulo, Brazil, is the world's leading coffee producer.

IMPROVISED AIR-DRIVEN GRINDER

THE accompanying pictures, published through the courtesy of *Iron Trade Review*, are interesting because they show what can be done in an emergency without the assistance of proper machinery. Confronted with the problem of surfacing the inside of a 10-inch pipe to be used in connection with an air hoist, and lacking a lathe suitable for the work, a manufacturer set about improvising a grinder that would answer the purpose. This he succeeded in doing by assembling, in the manner illustrated, a discarded grinding wheel; a 1-inch steel rod 6 feet long; a piece of band iron; two ¾-inch bolts; two pieces of ½-inch boiler plate; a few planks; and an air-driven drill. With this contrivance it was possible satisfactorily to grind the interior of the pipe. Next, the grinder was turned into a surfacer by substituting for the abrasive segments blocks of wood faced with emery cloth. In this way the remaining sharp edges on the inner surface of the pipe were removed.



Courtesy, The Boiler Maker.

Special rack developed in the Elizabethport shops of the Central Railroad of New Jersey for testing air motors.

ARC LAMP ACCELERATES DRYING OF OILS

LIGHT from the carbon arc lamp, so it has been discovered by the United States Bureau of Standards, is a better medium for the drying of oils than ordinary diffused light. Tests conducted to date by this Government have disclosed that the drying period in every case was greatly accelerated when the oils were subjected to the action of the arc light.

Linseed, perilla, and tung oils, for example, set in two hours, and candlenut, poppy-seed, menhaden, and soya-bean oils in from four to seven hours. So-called semi-drying oils—such as corn, cottonseed, and rubber-seed oils—were dry to the touch in about 24 hours. On the other hand, most of these same oils, when exposed to diffused light in a cabinet, took four days and more to dry thoroughly.

SPECIAL TESTING RACK FOR AIR MOTORS

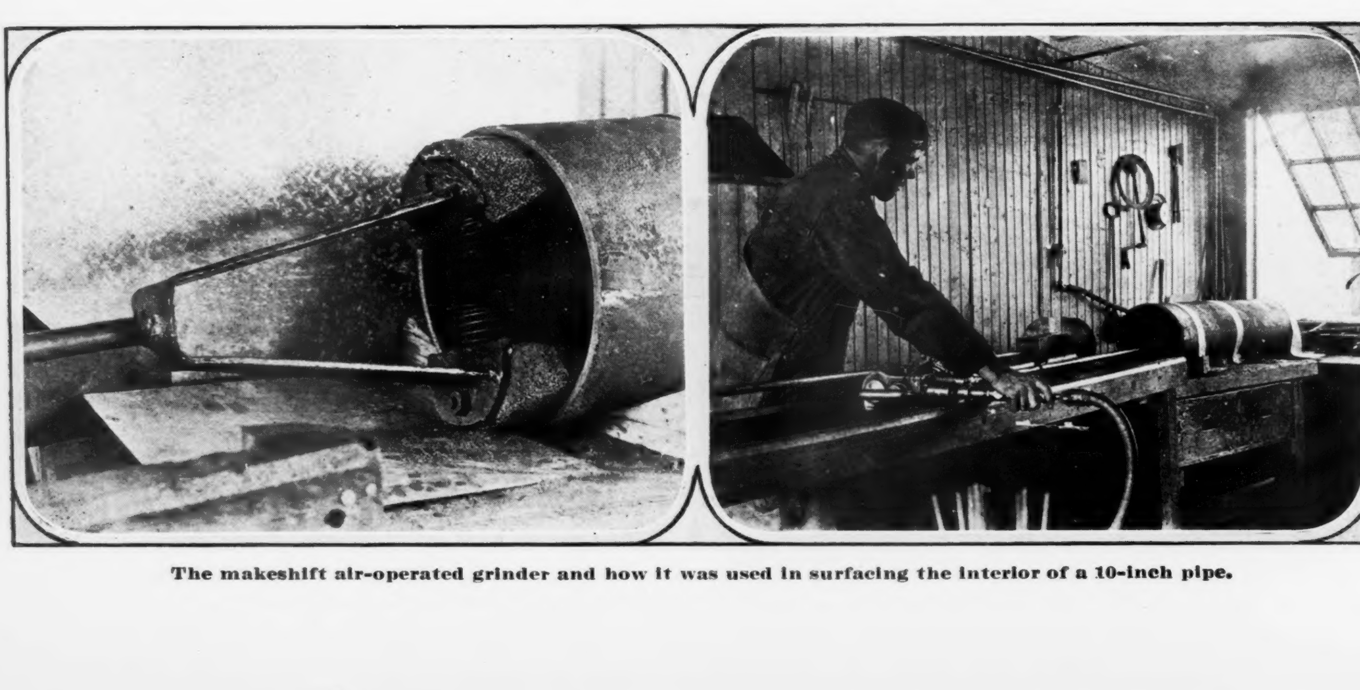
IN the Elizabethport, N. J., shops of the Central Railroad of New Jersey, where air-operated tools of all kinds are in use, it is now the practice to test the air motors in order to determine whether or not they develop their rated power. A special rack has been devised for this purpose which can be adjusted to take any size of motor in service there.

The rack, according to the *Boiler Maker*, consists essentially of a Prony brake, a pressure gage, platform scales, and a meter for measuring the air consumption in cubic feet per minute. To test a motor, the spindle is fitted to the Prony brake and the hose is attached to a connection on the rack leading to the shop air line. On the bench is a small platform scale for ascertaining the resistance on the Prony brake arm.

The brake horsepower of the motor is calculated from the regular formula for the Prony brake. All the known quantities—such as the length of the brake arm, and the weight of the arm and the pedestal on the scale—were determined at the time the rack was installed. The formula, in which the known quantities have been substituted, is painted in small letters on the rack for the guidance of the operator.

This rack has proved to be valuable in checking the power not only of new motors but of motors that have undergone repairs. All new motors received at the shop are tested on this rack, and the results of the tests are checked against the specifications by which they were purchased. Each motor coming out of the toolroom after repairs is also tested to make sure that it develops the required amount of power.

Each automobile in the United States now consumes on an average 500 gallons of gasoline annually.



The makeshift air-operated grinder and how it was used in surfacing the interior of a 10-inch pipe.

AIR-DRIVEN JACK HOISTS FOR RAILROAD USE

IN locomotive and car shops, especially in repair plants that have to deal with rolling stock of this nature, it is usually necessary to raise one or the other end for the purpose of making replacements or essential adjustments of various parts. Man-power jacks are frequently employed to perform this service; and a good many of us are well aware of the labor involved and the time required in such operations. To save time and labor, and, needless to say, expense, The Joyce-Cridland Company, of Dayton, Ohio, has devised air-motor-driven jack hoists that have won favor with a number of the largest railroads in the country.

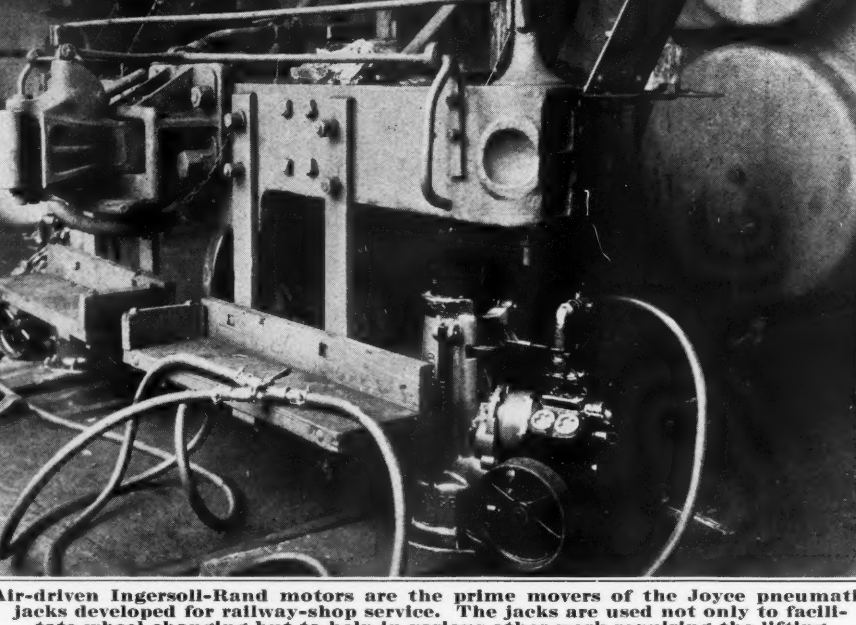
Jack hoists of this type are manufactured for three different purposes, and, therefore, in three sizes. One is designed for handling loaded freight cars; another for dealing with passenger coaches; and a third for raising locomotives. Each of these hoists has its own maximum rise—the lightest of them being for freight-car use and the heaviest for locomotive use. Naturally, the capacity of each hoist depends upon the air pressure and the speed of rise desired. For example, during a recent demonstration with a heavy Pullman, a pair of these air-motor-driven jack hoists raised one end of the car with air at a pressure of less than 30 pounds per square inch—requiring approximately eight minutes to do the work. Under normal conditions, with the usual pressure available in a shop line, a coach of that weight could be raised in three minutes, if not quicker.

These hoists are employed in the car department of railway shops principally to raise cars when changing wheels; but it should be self-evident that they are equally useful in doing many classes of car-repair work that necessitate jacking. In the locomotive department they replace ordinary jacks, and are utilized especially for draw-pin and booster inspection in which the rear end of the locomotive must be jacked. It is said that one pair of these hoists will take the place of as many as eight pairs of the familiar 50-ton, self-lowering coach hoists.

One of the most important characteristics of the Joyce air hoist is its safety in operation. It is not self-lowering—this movement being effected by reversing the motor. It is said that even in the event of a failure of the air supply there is no danger of the hoist running down or dropping. This is guarded against by automatic shut-offs at both the upper and the lower limits of the ram.

Man-power jacking, even with the most modern jacks, is hard and tiring work; and after a heavy coach or locomotive has been hand jacked by a gang of four or six, the men are usually tired out and must rest in order to catch their breath. With pneumatic hoists of the kind here considered, one man can control the raising and the lowering of the load without any appreciable effort. Therefore, by avoiding back-breaking labor, the physical energy of the men is conserved and they are able to carry on better the whole day through than would be the case if they had to operate hand jacks.

The Joyce air-motor-driven hoist is actuated by an Ingersoll-Rand, heavy-duty motor. The reasons for the choice of this type of prime mover is thus stated by The Joyce-Cridland Company: "Because of its extraordinary power; its method of construction, which makes it easily adaptable to the rest of the mechanism of the hoist; its simple and desirable method of air control; the fact that parts can be renewed and cylinders replaced—thus eliminating the necessity of reboring; its accessibility and the ease with which it can be repaired; and, finally, because of the reputation of its manufacturer."



Air-driven Ingersoll-Rand motors are the prime movers of the Joyce pneumatic jacks developed for railway-shop service. The jacks are used not only to facilitate wheel changing but to help in various other work requiring the lifting of coaches, freight cars, and locomotives.

One of the Weaver air-operated tire-changing machines showing the rim split and ready to receive its tire.

CHANGING TIRES BY MACHINE

THE work of removing and of changing tires on trucks and cars is no longer in the manual-labor class; and garages, maintained either by private interests or for the convenience of the public, now have at their service machines that have turned back-breaking labor into child's play. These machines are designed to change tires on split rims and to strip tires from solid rims and from disk and wire wheels.

The accompanying illustration shows the newest form of split-rim tire changer made by the Weaver Manufacturing Company. This apparatus can be adjusted to take split rims of various kinds from 18 to 24 inches in size, and is operated by compressed air. The air is controlled by a 2-way valve which, in turn, serves to control a jaw. This 2-way valve has been developed especially by the Weaver Manufacturing Company, and is said to be leakproof.

In removing a tire, the jaw is forced inward under the impulse of the air, thus splitting the rim and contracting it sufficiently to enable the operator to free the tire by a spiral motion. There is little if any danger of distorting the rim the while, as it is gripped firmly by the machine. Besides, the travel of the jaw is limited to prevent over-expansion or contraction of the rim, as the case may be. To remount the tire, the lever of the 2-way valve is turned to the left. This action reverses the movement of the jaw and permits it to restore the rim to its proper position against the tire. As every motorist probably has learned from experience what it means to change a tire, the value of equipment of this sort in a busy garage need not be emphasized here.

Compressed Air Prevents Formation of Ice Along Spillway

A COMPRESSED-air system for preventing ice formation along spillway flashboards has been in successful operation for several winters on the Tippecanoe River in Indiana at the Norway plant of the Indiana Hydro-Electric Power Company. The flood-discharge works at this plant consist of three stony gates and of an overflow spillway 225 feet long. This spillway is a solid masonry dam, the crest of which carries 2-foot flashboards supported on conventional steel pins or rods. The pond level is generally carried within 6 inches of the top of these boards; and if ice were allowed to form against them they would soon be carried off. In the past, an open channel had been maintained along the boards by chopping away the ice—the men standing on the narrow ledge behind the boards. This work was hazardous and expensive, and some improved scheme was sought.

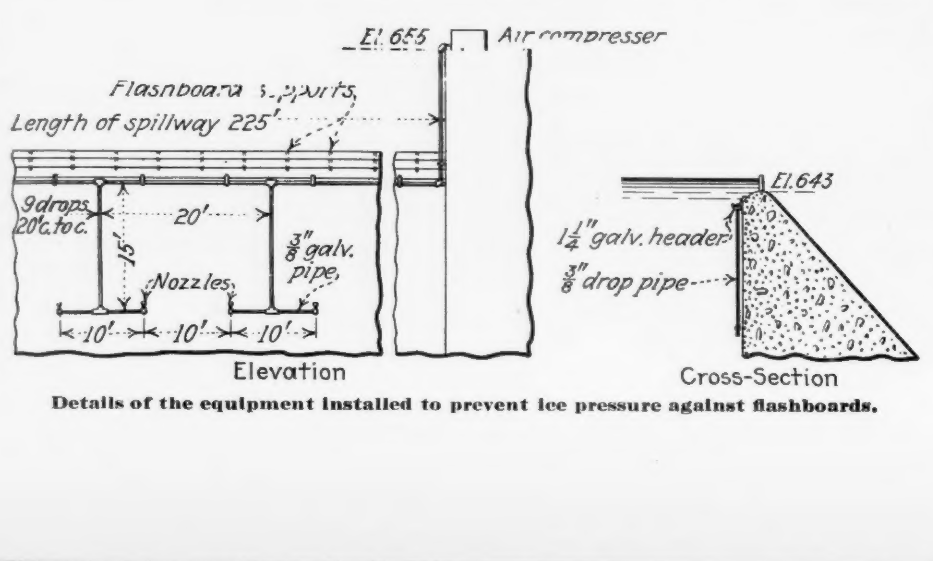
Open area of water maintained by jets of compressed air. Thus ice pressure against the flashboards is prevented.

A permanent addition to the top of the spillway was not feasible because it would represent an encroachment on its discharge capacity and because the masonry section was insufficient to withstand ice loading at the higher level. Collapsible flashboards set at an angle flat enough to turn the expanding ice were considered, but it was found that such a system would cost more than the use of compressed air. It was decided, therefore, to keep an open channel in front of the flashboards by means of air discharged underwater. Normally, no trouble arises from drifting floes of ice because the velocity in the pond is very low and the ice sheet generally melts away in place.

The location and the arrangement of the air piping are shown in the accompanying diagrams of the elevation and the cross section. The air outlets or nozzles, which are simply pipe caps with proper-sized holes drilled in them, were originally spaced on 20-foot centers, but this spacing allowed ice to form between the outlets. The eleven outlets were graduated in size from $\frac{1}{16}$ inch nearest the supply to $\frac{5}{16}$ inch at the farthest outlet. With this graduation too much air was delivered at the far end. The number of outlets was then doubled—making 22—by adding a 10-foot tee extension at the bottom of each drop, as illustrated, with an outlet at each end. This placed the outlets on 10-foot centers. The openings were also decreased in size from $\frac{1}{32}$ inch at the source to $\frac{5}{32}$ inch at the remotest point. This arrangement proved satisfactory.

The pressure at the compressor is about 10 pounds per square inch, being equivalent to the hydrostatic pressure at the nozzles plus the velocity and friction losses It was discovered that a slight slope on the cross tee supporting each pair of nozzles would give one nozzle more air than the other. For this reason individual drops to each nozzle are to be preferred.

The compressor is belted to a 5-hp. motor making 1 800 revolutions per minute, and it delivers 13 cubic feet of free air per minute.



Details of the equipment installed to prevent ice pressure against flashboards.

The unit is mounted on top of one of the floodgate piers; and although protected from rain and snow by an inclosure no attempt has been made to keep it warm. No difficulty has been experienced either with the compressor or the air lines on account of low temperatures.

Note—This article by F. A. Dale, hydro-electric engineer of the Indiana Hydro-Electric Power Company, is reprinted by courtesy of the Electrical World.

The outer envelope and the 30 gas cells of the *Graf Zeppelin* contain 60,000 square yards of cotton fabric.

DESTROYING FLIES ON A LIVESTOCK FARM

ON a hog farm, on the outskirts of Los Angeles, Calif., where 400 tons of garbage from that city are consumed daily, it is the practice to spray the grounds and buildings twice every 24 hours with an insecticide to keep away troublesome flies. The outfit used for this purpose consists of a 150-gallon tank and of a small compressor mounted on a horse-drawn truck.

Every morning and evening, when the flies have settled down and are least active, the wagon covers the farm and destroys the pests with a mixture composed principally of a stove distillate containing small percentages of "Cresole" and oil of myrbane. Great care is taken so as not to come in contact with the livestock, as the myrbane is powerful enough to cause burns.

A long-handled spray gun is provided to facilitate reaching the tops of the 1-story pens on the farm: and from this gun the exterminator is discharged under a pressure of 150 pounds per square inch. The unit is operated by two men.

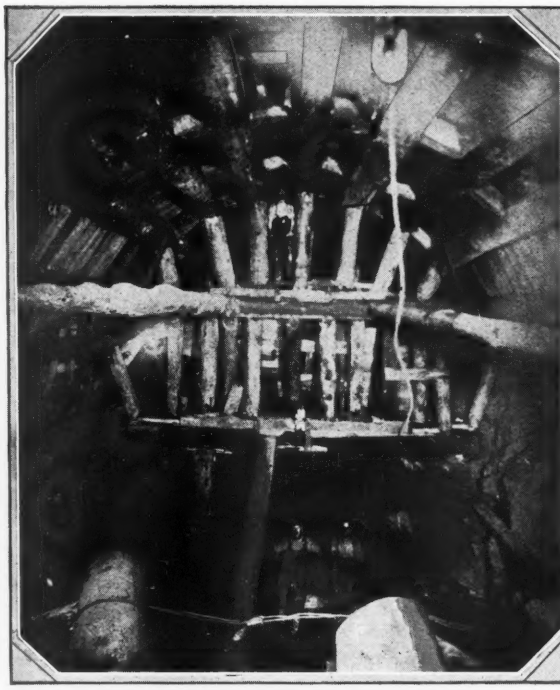
Two dirigibles, to be known as the *ZRS-4* and the *ZRS-5*, are to be built for the United States Navy by the Goodyear Zeppelin Corporation at a cost of $7,825,000.

Reminiscences of a Retired Sand Hog

By PATRICK RYAN

AS an old-timer who has worked on some of the largest compressed-air jobs in Europe and the United States, my attention was attracted by the comments of some businessmen that rode with me through the Holland Tunnel not long ago. It was clear to me that most of them were unaware of the risks run by workmen engaged in subaqueous undertakings of this kind. Therefore it has occurred to me that the readers of *Compressed Air Magazine* would be interested in certain experiences of mine when actively employed in underwater operations.

Men that work under compressed air are often attacked with what is known in Europe as "caisson fever"—more familiarly termed the "bends" in the United States. This malady long puzzled the doctors. Morphine, ergot of rye, opium, and Jamaica ginger were given to relieve attacks. In cases affecting the arms and legs, the galvanic battery was used. Hot applications, vigorous rubbing with strong liniments, also stimulants, hot drinks, and hot baths gave relief at times. I have known sufferers to drink very large quantities of brandy without showing signs of intoxication. In the old days, besides fatal cases, many compressed-air workers suffered ruptured ear drums, partial or complete paralysis, and prostate trouble.



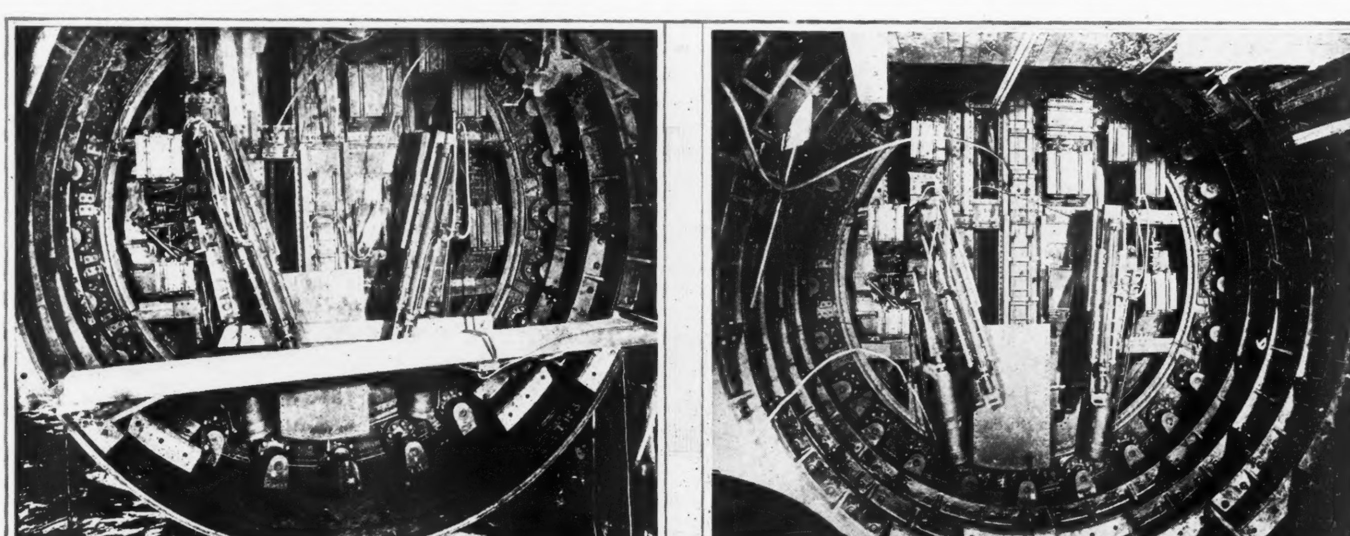
Method of timbering used in the Long Island section of one of the East River tunnels where the floor was in rock and the roof in soft ground. This section was driven by hand.

My first experience with air work was in sinking the caissons for the Forth Bridge, Scotland, in 1885. In connection with that undertaking there were many serious cases of the bends. In 1889, I visited a section of the City and South London Tube Railway, then building in Lambeth, and while there was subjected to 23 pounds pressure for a period of three hours for test purposes. Slight attacks of the bends occurred among the workmen on that job. Later, I learned from experience that the danger line was when the pressure reached 2 atmospheres, about 28 pounds—the risk to health and life increasing as the pressure rises above that limit.

My next task was to inspect, at an ironworks in Glasgow, Scotland, the construction of shields to be used in driving the Hudson River tunnels. The old brick tunnel had been advanced about a quarter of a mile from the Jersey shore after twenty years of effort. Then, on the advice of Sir Benjamin Baker, it was decided to abandon the method employed and to continue operations with shields, using cast-iron segments for lining. In 1890 I came to New York and superintended the work.

In order to erect the shield, an enlarged chamber had to be built at the extreme outer section of the brick tunnel with a timber bulkhead at the forward end to hold back the silt. The air pressure averaged 35 pounds—being carefully adjusted to the rise and fall of the tide because too much pressure was liable to lift the soft roof away, and cause a "blow", and too little would permit silt to flow in at the bottom. We had one serious blow. The bulkhead collapsed; the whole chamber filled with silt; and the men barely escaped with their lives, nearly duplicating an accident in the same tunnel many years before resulting in the loss of about twenty lives. The end of the chamber was ingeniously plugged with a large ball made of bales of esparto grass bound firmly together in a net of wire ropes and lowered into place from a floating derrick.

Fitted to the river forge, used in erecting the shield, was a sheet-iron hood. This was connected to a pipe leading out to the atmosphere so as to carry away the smoke and gas. A small sliding door at the side of the forge enabled the rivet heater to replenish the fire and to reach his rivets. This seemed to serve well; but the cases of bends increased and the heat of the chamber rose from 75° F. to over 100°. We perspired so freely that we often drained a quarter of a pint of perspiration from our rubber boots at the end of a shift. A Cornell professor took a sample of the air and found that it contained a dangerous amount of gas caused by the heater.

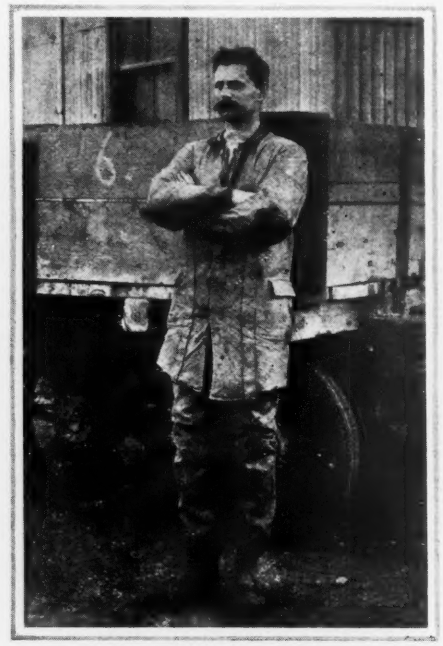


Back views of shields used in driving the East River tunnels for the Pennsylvania Railroad. Note the type of erectors employed.

After the lower half of the shield was thus riveted it was decided to employ bolts for the upper half and to dispense with the fire, as foul air, combined with the high pressure, was responsible for much illness among the workers. Cases of bends occurred daily. Some ended in permanent paralysis, some in death. I had slight attacks in both arms and legs, but got relief from the galvanic battery, liniments, and hot salt bags. The pain in the joints is like acute rheumatism, with shooting pains between the joints. When I felt a sensation like "pins and needles" on the thin skin of my instep, I knew that I would soon be restored to normal.

It may be interesting to learn that when the pressure is 16 pounds, one is unable to whistle; it becomes difficult to whisper; the voice has a nasal sound; a cigarette burns twice as fast; and damp lumber burns fiercely. I have tried to blow out a lighted candle in air at 35 pounds pressure, but the flame would vanish for an instant only to flare up again immediately owing to the increased oxygen. In a tunnel as in a diving dress there is much the same feeling of humidity, and the temperature is higher than normal. At 35 pounds, with all heavy clothes removed, I sweated freely, and the sensation is one of pleasant exhilaration. On leaving a tunnel, the heavy clothes are replaced before entering the air-lock for decompression. As the pressure decreases a mist or fog arises and a chilliness is felt that increases until normal air pressure is restored.

The first symptoms of an attack of bends occur generally from 30 to 70 minutes after decompression. Several of the older workers and myself found that when we took a long time to decompress we escaped the trouble. Also, I learned that if I had suffered overnight, I would be all right again the next day after going into the pressure chamber. On three different occasions, in severe cases of bends, the men fell into a state of coma. While they lay helpless, the doctor cut them on the arms, and the blood gushed out with great force. If this was an experiment, it was a failure, as all died a few hours after the lance was used.



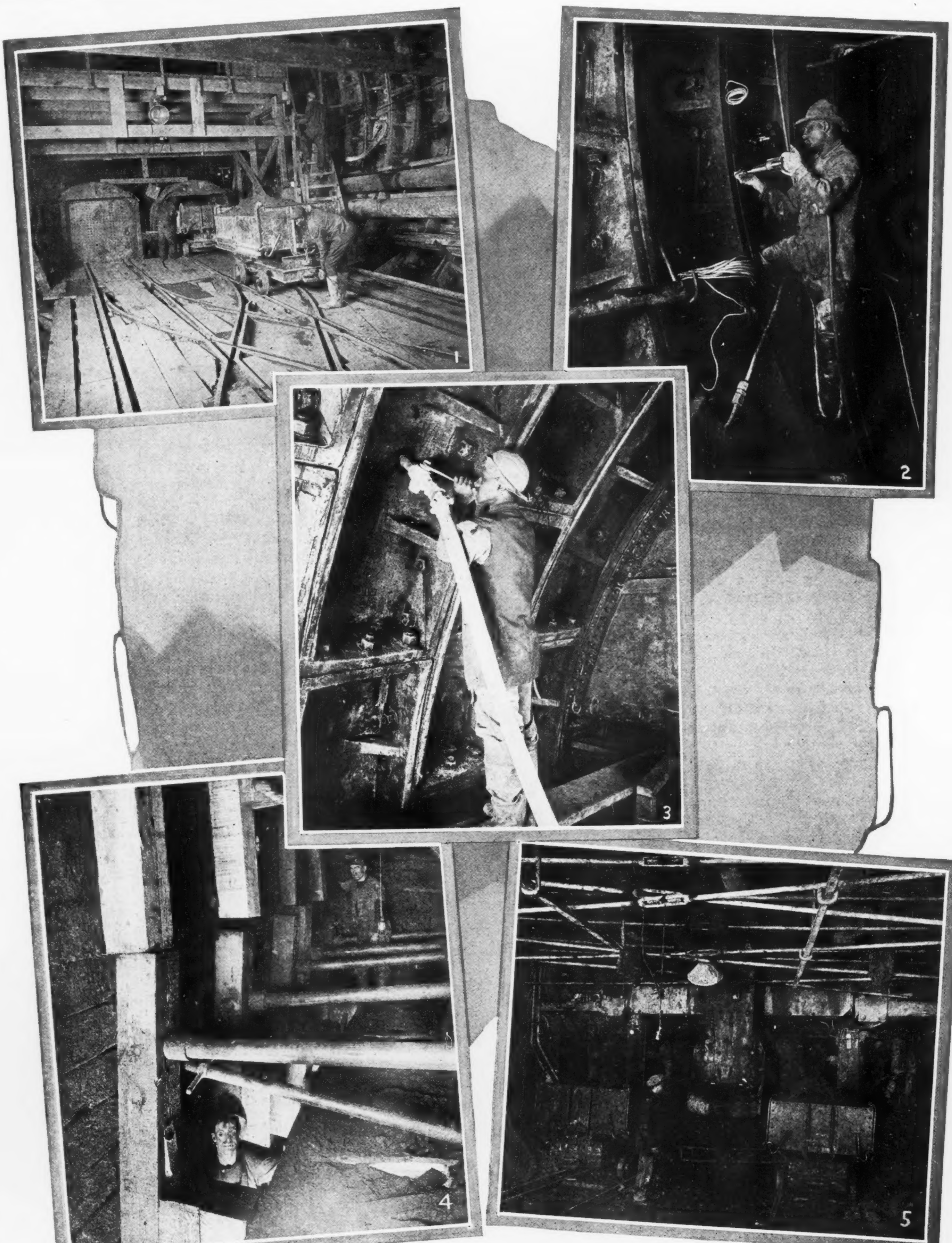
Sir Ernest W. Moir, chief engineer of the Blackwall Tunnel which was built under the Thames by S. Pearson & Son, Inc.

On Palm Sunday, 1890, I remained too long in the tunnel. Half an hour after leaving the lock I was seized with a very bad attack—gradually becoming paralyzed. I experienced a feeling of numbness, with shooting pains at intervals rushing from joint to joint. I thought my time had come, and gave instructions to send my valuables to my parents. Before I fell into a coma I begged my friends not to allow the doctor to cut me. That was a close call; but in a week I was able to get around again.

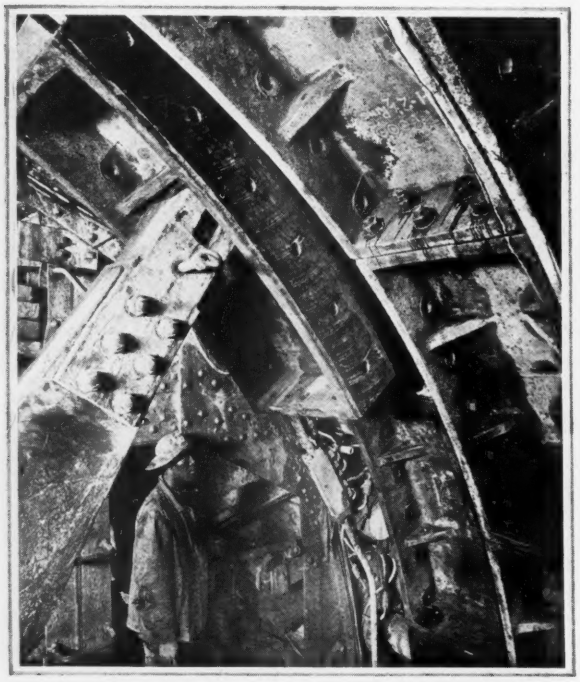
When the late Lord Cowdray—then Weetman Pearson of S. Pearson & Son, Inc., who had this contract—went into the tunnel on one occasion, he was seized later with the bends. While lying ill he informed one of his engineers that he thought of giving up the contract as he did not wish his workmen to undergo dangers that he himself could not withstand. But the engineer, now Sir Ernest W. Moir, had been giving the subject much study, and had decided that the trouble was due to too rapid a decompression. He had the decompression valves reduced—in that way lengthening the period of decompression. This change resulted in a decrease in the number of cases. He also had made an air-lock, and this was placed near the shaft above ground. It was fitted with electric lights, a bed, a medicine cabinet, etc. Men attacked with bends after leaving the tunnel were placed in this medical air-lock. There the air was allowed to decompress slowly; and the effect was almost magical. I have seen men carried into the lock helpless with pain, others with vertigo or "staggers", and as soon as the pressure was raised their troubles vanished, their look of terror and despair gave way to smiles of relief. Resting comfortably during decompression, they walked away cured an hour later. The great value of this invention is shown in the remarkable saving of life. Before the use of Moir's medical air-lock, 12 deaths occurred in a year among about 50 workmen, or 24 per cent. After its introduction, the death rate dropped to less than 1 per cent.

On compressed-air work, with all its risks and dangers, there are sometimes humorous incidents. We had negro mule drivers to

Left—New Jersey side of the Hudson River Tunnel, showing first lock built in the cast-iron lining. This picture was taken in 1892. Right—Patrick Ryan, at right, on the job.



1—Muck cars coming through an air-lock at rear of one of the shields of a subaqueous tunnel. 2—Air-driven chipping hammer used to calk seams between iron segments of tunnel lining. 3—Compressed air forcing grout into space between tunnel lining and excavated ground to insure consolidation. 4—Breast boards and cutting edge of a shield in one of the tubes of the Holland Tunnel. 5—Loading muck cars immediately to the rear of a shield in one of the tubes of the Holland Tunnel.



Erector shoving cast-iron section of a lining ring into position.

haul spoil cars from the hoist to the dump along the docks. One day a mule gave a driver a rather vicious kick and knocked the wind out of him. The orderlies saw the man lying doubled up with pain, and, thinking it was a bad case of the bends, carried him over to the medical air-lock and put him under 30 pounds air pressure. Shortly, the foreman missed the driver. He hunted all over the place for him and, finally, looking through the glass window of the air-lock, saw the orderlies rubbing the bewildered, perspiring negro driver. He seized the telephone and with a torrent of oaths convinced the astonished attendants that the man had not been underground. The darky, however, fully recovering his wind and senses, remarked, "Yes, sir, dat is de greatest mahshine in de worl'. Wo'ks both ways—if you gets too much air it fixes yo, and if yo ain't got enough wind it fixes yo des de same."

My next experience under compressed air was in 1892 as a diver, recovering links and buckets which had been dropped from time to time from dredgers operating in the Grand Canal of Mexico. A shipment of new spare parts had been lost with a vessel in the Gulf of Mexico; and I had volunteered to go down and salve the old buckets and chain links from the canal, also an anchor scow and winch boat, so as to avoid shutting down the work on the Couloir dredgers. With two Mexican Indians to man the air pump, and a young Englishman, Jack Wright, to act as lifesman, I went through the canal and salvaged all the equipment, besides attending to my regular job—that of superintendent of construction.

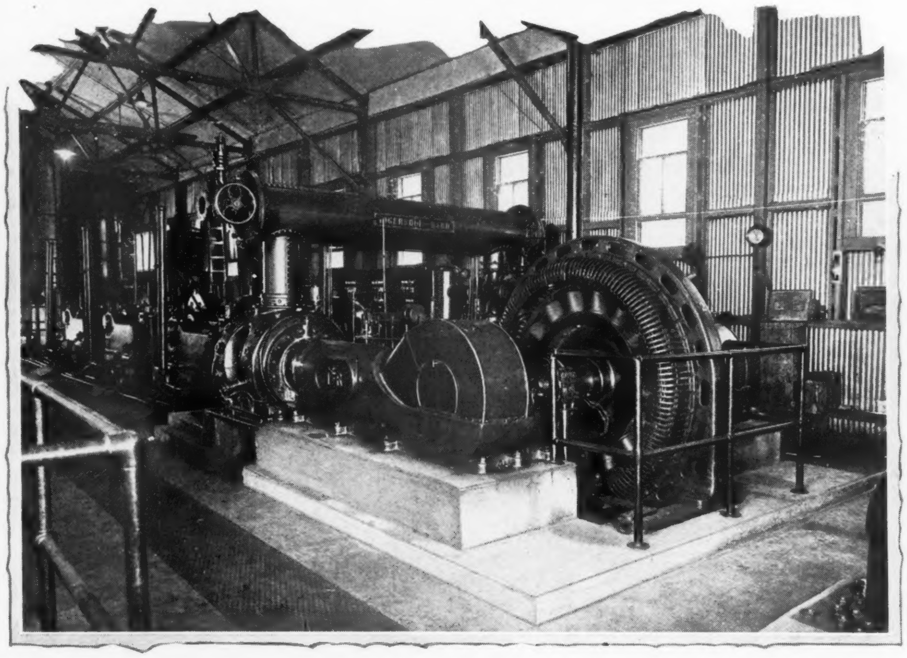
To recover the buckets, etc., I had to go down to a depth of from 30 to 35 feet; and the bottom was so soft that I had to wrap burlap around my leaden shoes to prevent sinking too deeply into it. The anchor boat I found resting on a ledge. When I touched it, the boat turned over and nearly trapped me. This made me realize that a mishap would be a very serious thing, as the nearest diving gear and diver were at Vera Cruz, over 200 miles away. The people around San Cristobal had never seen a diver at work; and in the beginning about 500, mostly Indians, came to watch that strange spectacle. The waters there were so muddy that the bright sunlight penetrated to a depth of only 12 feet.

We were nearing the end of operations when I had an experience that almost cost me my life. Locating a group of buckets and links one evening, I arranged to go down and fasten the lifting chains the following morning, so we left our boat with the diving gear moored up in line with the sunken material. The next day, before breakfast, I hurried into my diving dress and descended—expecting to complete the job in half an hour. But I failed to locate the buckets. Walking backward and forward on the mud bottom in my effort to find them proved very exhausting; and in doing so the linesman left too much slack rope and air pipe, especially when I went in the direction of the boat. Suddenly I slid down into a hole about 8 feet below the level I had been on. At once I tried to shut off my exhaust valve and to adjust the air pressure to my new depth, but somehow the response was not quick enough. My legs were being drawn down into the mud, and I felt the pressure of the water crushing me. Trying to signal to Wright, I hauled in yards and yards of rope, but got no answering signal. The pressure forced me flat on my back into the mud, and I believe I fainted. I heard sweet bell-like music, and I seemed to float through blue and purple clouds. Important events in my life passed vividly before me. I saw a vision of a priest calling on my family in far-away Scotland and telling them that Pat had been drowned in the canal in Mexico.

Meanwhile, condensed water, collecting on the inside of my helmet, kept dropping on my brow. This seemed to rouse me. I prayed loudly, grasping the life line and pulling it desperately. Finally, getting a response, I signaled to "haul up", and felt myself lifted from the cold mud and darkness through gradually increasing warmth and light into the glare of the glorious, tropical sun. "Surely, my sins have been forgiven", I thought, "and I am in the presence of The Almighty." In fact, when I realized I was on earth and still alive I almost regretted my resurrection. As the lifesman took off my face glass he remarked that I had been a long time in that spot. "God, you do look white, what happened"? he said. I did not tell him. Years afterwards, however, I met Wright, and told him the whole story. Our diving boat, we found, must have been moved by someone during the night. After a drink, I went down and completed the work.

In 1893 I was requested to visit the office of a contractor in Glasgow who was constructing a section of the city subway. My references as a superintendent proving satisfactory, I was asked to go and look over the job. They supplied me with rubber boots and oilskins; and on entering the tunnel I was given a candle, as there were no electric lights underground. The compressed-air plant seemed to me inadequate—the air pressure was about 22 pounds; and the cast-iron lining had flattened and was held together horizontally by strong chains and union screws. At the face the silt was soft, and it was flowing at the bottom. The forward end of the shield had sunk so far out of line in the silt that the tail end at the top had come off the cast-iron

Top heading in one of the East River tunnels, looking west.



Subaqueous tunnel-driving requires large supplies of compressed air for various uses. This is one of the compressor plants installed while building the Holland Tunnel.

lining of the tunnel and was actually a few inches below it. There was no ventilation to ensure a fresh supply of air. The candles burned with a smoky flame, and the air was charged with soot. The workmen, with soot clinging to their moustaches and nostrils, looked pale and ill; and there was much sickness among them. I recommended an increased air plant, the installation of electric light, and the pumping of a regular supply of fresh air into the tunnel. Unless this was agreed to, I said, I would not work with them.

In the meantime I was appointed superintendent on the Blackwall Tunnel, under the Thames, London, the largest subaqueous vehicular tunnel in the world at that time. S. Pearson & Son, Inc., were the contractors, and E. W. Moir was chief engineer. The air pressure used ranged from 25 to 35 pounds. In the concrete bulkheads of the tunnel were built three air-locks: two on the lower level for materials, and one emergency lock for the men as near the top as possible. The wisdom of this arrangement was demonstrated later when we had serious "blows". Twice the water rose in the tunnel to a point above the lower locks—the men having ample time to escape through the top lock. Another advantage of the upper lock was that the men could take a longer time for decompression, as it did not interfere with the passing of materials into the lower locks.

Men applying for work on the Blackwall Tunnel were first examined by a resident doctor. Then they were initiated, so to speak—putting in two hours under pressure the first day, and three hours the second day. These tests passed satisfactorily, the men were engaged. Workers were supplied with warm, felt coats; and on coming out, before entering the decompression lock, each was given a half pint of strong coffee.

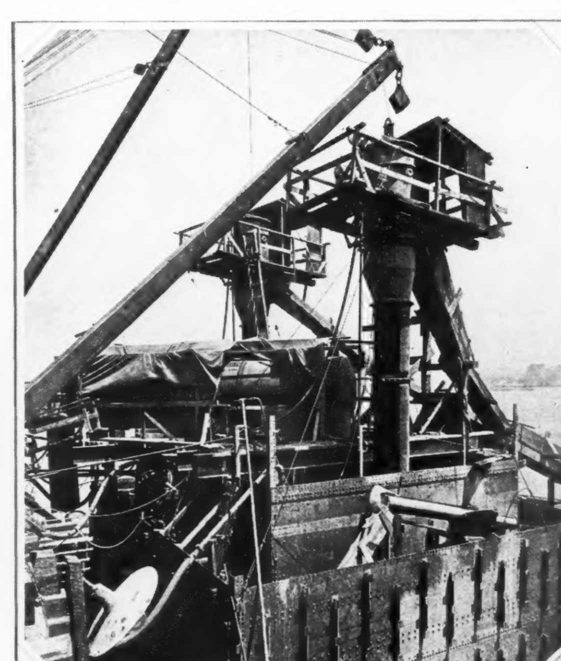
Near the shaft, on the surface, was installed a medical air-lock where men seized with bends could be slowly decompressed. There were 200 such patients necessitating attention, but no deaths. Some of us old-time "airmen" noted certain cases which the doctors diagnosed as rheumatism but which we thought were bends. I observed that there were fewer cases of bends when we were working in gravel at the face and a large amount of air was escaping than when the face was in clay and little air was being lost at the face. To improve this condition, an exhaust pipe was opened to the atmosphere. This insured better ventilation through regulated leakage. Stout men do not stand the pressure as well as thin men. Pale men do better than full-blooded robust-looking men.

The London County Council provided a pension for men injured as the result of work under air pressure. I had an ironworker who failed to pass the physical examination. The doctor informed me he had serious lung trouble, and agreed to let him start only if he would waive his claim for compensation should he be incapacitated. He did so. Being very thin and pale he thrived under compressed air, and became stout and healthy. The extra oxygen in the tunnel seemed to be just what he required; and long before the tunnel was finished he had become the strongest man on the job. It seems that nature assists those engaged in this hazardous calling in a thoroughly unnatural environment, for men that labor under pressure daily usually escape the bends. When these same men take a vacation and then resume their compressed-air work, they often get the bends on the first shift or two.

When the shield at last reached the Poplar side of the river and entered the caisson successfully, great satisfaction was expressed by the County Council of London, and they decided to celebrate the event with a unique luncheon to be served in the caisson under 30 pounds of compressed air. Spears & Ponds, the well-known caterers, had decorators convert the interior into an elegant dining place. Wines and liquors of the best quality were brought in: and carpenters were set to work boring tiny holes in the corks of all the bottles to equalize the pressure so as to facilitate pulling them.

The guests consisted of a large party of city aldermen and mayors from adjacent districts. Fitted with rubber boots, overalls and sou'westers, they passed on through the tunnel and reached the caisson safely; and then the celebration began. The temperature was high, and this increased the diners' thirst. However, the champagne did not sparkle in the glasses as usual: it had not that clinging effect on the palate that champagne has under normal conditions. The high air pressure prevented the carbonic gas from escaping, and it seemed more like a still wine. Although many complained that the champagne was poor, they drank to the health of Her Majesty, Queen Victoria, and to the Prince of Wales, the army, the navy, the Lord Mayor of London, and others, until the champagne and liquors were exhausted.

The party finally started on its way out, feeling happy and gay. The guests took their places in the decompression lock. After the pressure had been lowered about 10 pounds the gayety suddenly left their faces. At 15 pounds decrease they began frothing at the mouth. If that champagne was quiet and still when consumed under high pressure, it was surely raising the very devil now, and could



Sinking a caisson for a subaqueous tunnel.

not be kept down. The thing became alarming when some of the company began to tumble about the lock. The man at the valve then wisely raised the pressure again. The effect was marvelous, all sickness stopped. There was a hurried consultation, and it was agreed to treat all who had had champagne with emetics or stomach pumps so to avoid trouble upon reaching the normal atmosphere. With this done, decompression caused no further distress; but I never saw a sadder looking lot of men in my life than those aldermen and mayors. We were all pledged to secrecy to prevent the evening papers from depicting the scene of the officials in their sorry plight.

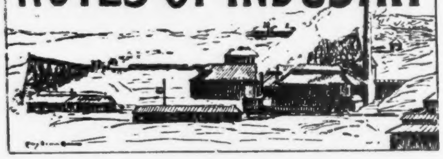
From 1903 until 1909 I was superintendent for the Pennsylvania Railroad on the four East River tunnels from Long Island to New York City. S. Pearson & Son, Inc., were the contractors. The tubes are 23 feet in diameter, and the roofs about 20 feet beneath the river bottom. Air pressure ranged from 26 to 39 pounds per square inch. On this job the resident engineer, now Sir Henry Japp, introduced his graduated air valves for decompression, and these were very useful in preventing the bends.

Moir's medical air-locks were provided on both sides of the river; and a staff of six doctors with orderlies were engaged to examine the workers and to attend those attacked with the bends. Each lock was equipped with two beds, a telephone, and electric light and heat. During the entire undertaking 1,419 patients were thus treated for bends, and of that total only 8 per cent failed to get relief. In my opinion the failure in those cases was due mainly to delayed decompression. I have knowledge of eight deaths caused by the disease; but there may have been more.

It was found that by placing a second bulkhead with locks 500 feet away from the first one—thus causing a break in decompression and compelling the men to exercise by walking between locks—a marked decrease in the number of cases occurred. In April, 1908, we had a period of high-pressure work in removing broken segments from the bottoms of the tunnels. The air pressure reached 39 pounds per square inch. We had 3-stage decompression—that is, five minutes were spent in passing through the first bulkhead; then followed a 500-foot walk to the second bulkhead where eight minutes were taken up in decompression; and, next, came another 500-foot walk to the third bulkhead in which the men remained fifteen minutes before being restored to the normal atmosphere. This well-thought-out plan resulted in a reduction in cases of bends. In fact, there were fewer attacks during this period of high-pressure work than when we were operating under lower pressure with single- or double-stage decompression. The schedule was six hours of work in two 3-hour shifts with a 3-hour rest between. Men of many different nationalities were on this job, and Anglo-Saxons and negroes stood the pressure best.

My last ventures in compressed air were in 1914 as a diver. That year I inspected the 12-inch water main laid on the bed of the Mohawk River for the Town of Fort Plain, N. Y. Later I went down again in the same river to assist in raising a sunken dredge. Then I came to the conclusion that compressed-air work, especially diving, is a young man's game and too strenuous for a man nearing fifty.

NOTES OF INDUSTRY



Great strides are being made in the development and the equipment of certain promising mercury properties in Nevada, and it is predicted by those that are in touch with the business that that state will soon become the leading producer of quicksilver in the West.

At the present time, gasoline is being consumed in the United States at a rate approximately 13 per cent greater than in 1927. Our monthly consumption now averages 925,624,000 gallons.

Two and one-half billion passengers paid for riding in motor buses in the United States during 1927. There are now in this country 7,000 motor-bus systems that operate a matter of 85,000 buses.

Chicago boasts a consolidated ticket office for the convenience of persons wishing to travel jointly by bus and air routes. The associate organizations now operate 6,160 miles of airways; and the bus service will cover transportation to and from the various contributive landing fields.

Work has been begun in Toronto, Canada, reports the *United States Daily*, on a pneumatic tube system that is designed exclusively for the handling of telegrams. The system will link the telegraph offices of the Canadian National Railways and of the Canadian Pacific Railways with the Union Station and the Royal York Hotel, which is now in course of construction. By this underground route, it will be possible to transfer telegrams from one point to another in one minute, or at the rate of 30 miles an hour.

Every automobile manufactured nowadays has about 35 pounds of cotton in its get-up in the shape of tires, seat cushions and covers, tops, and other parts.

Work is to be started during the coming dry season on the survey of the proposed Transisthmian Highway in the Panama Canal Zone. A sum of $40,000 has already been appropriated for the purpose.

Plans have been prepared for the Vancouver Harbor Commission which would give that British Columbia port a tideless fresh-water harbor and, at the same time, reduce the heavy currents that are now encountered there by shipping. The *Engineering News-Record* announces that the project would call for a dam across Second Narrows, including a reversing spillway 100 feet wide, a causeway, and two locks: one for deep-sea vessels and the other for light harbor traffic. Bascule bridges across the entrances to the locks would permit vehicular traffic over the causeway, which would replace the present bridge. It is estimated that the work could be finished in the course of three years at a cost of $5,000,000.

Gilsonite is one of the oldest known minerals in the world, reports the United States Bureau of Mines, and in this country is mined only in the State of Utah. It is a brilliant, black, asphaltic substance and is used in the manufacture of varnish, paint, electrical insulation, inks, telephone mouthpieces, electric switch handles, knobs, buttons, etc. The transportation of gilsonite to the consuming public is started over one of the world's steepest and crookedest railroads, which crosses Baxter Pass at an elevation of 8,437 feet. The trains actually travel 24 miles between points only 6 miles apart as the crow flies.

A deposit of high-grade bituminous coal has been discovered at Little Forks, about seven miles from Springhill, that is said to be one of the richest found in Nova Scotia in years. It consists of two seams: one a little more than 3 feet thick, 35 feet below the surface, and another 5 feet thick lying about 65 feet deep.

Motion-picture producers are watching with interest demonstrations of a paper film invented after years of experimenting by a Berlin engineer. It is said that the cheaper paper film possesses the same light sensibility as the celluloid product, and may be made noninflammable.

Figures compiled by the American Motorists Association disclose that an average of $229 was spent by each motorist in the United States during 1927 in the operation and maintenance of his car. Of this sum, $101, or 44 per cent, was paid for fuel and lubricants—the largest item in his annual expense bill.

Efforts are being made to substitute peanut shells for wood chips now put into gypsum-fiber concrete to lighten it. Concrete of this description is used in the making of floors and roofs; and the object of the tests, which are being conducted by the United States Bureau of Standards, is to cut the cost of the material rather than to improve it. The wood chips generally employed for the purpose must be of regulation size, and are therefore comparatively expensive.

Compressed Air Magazine

—Founded 1896—

Devoted to the mechanical arts in general, especially to all useful applications of compressed air and to everything pneumatic.

Business and Editorial Offices:

Bowling Green Building, No. 11 Broadway, New York City
Tel. Bowling Green. 8430

Publication Office: Phillipsburg, New Jersey

TERMS OF SUBSCRIPTION

$3 a year, U. S. A., American possessions and Mexico; all other countries $3.50 a year, postage prepaid. Single copies, 35 cents.

EDITORIALS

The Season's Greetings

WE wish you a Happy New Year; and we trust that 1929 will be for each and all of you a twelvemonth of prosperity and success in your various lines of endeavor.

We feel that this wish, hearty as it is, is but a small return for what our readers have contributed to us in the way of inspiration and material help in our particular field of work.

More and more it is brought home to us that we cannot give the fullness of service that we desire unless we have the cordial support of our readers and the benefit of their constructive comments.

In the year gone, we have been aided generously in this respect; and we hope that we shall be able to count confidently upon a still greater measure of this coöperation in the current year.

MOST INDUSTRIAL ACCIDENTS AVOIDABLE

AMAZING as it may seem, nevertheless we are authoritatively informed that 98 per cent of industrial accidents occurring in the United States are preventable. This is the pronouncement of H. W. HEINRICH, assistant superintendent of the engineering and inspection division of a well-known insurance company.

Mr. HEINRICH declares that 88 per cent of all industrial accidents can be prevented by the enforcement of proper safety rules, while the remaining 10 per cent is directly traceable to faulty physical conditions within plants. Heartening as it is to learn that only 2 per cent of the total number of accidents is unforeseen or unpreventable, still the fact that 98 per cent could be avoided by the exercise of care and the correction of physical conditions of plants makes it all the more evident that no time should be lost and no pains should be spared to reduce the likelihood of these preventable accidents.

Even apart from the humanitarian urge, there is a convincing reason for precautionary measures that will prove effective. Accidents cost industry approximately $5,000,000,000 annually! The authority quoted has stated that accidents in industry can be reduced 50 per cent in a short time, and that this can be accomplished chiefly through the revision of present accident-prevention practices. Such being the case, a start in the right direction should be made at once.

BETTER LATE THAN NEVER

NEWS it probably will be to many of our readers to learn that the United States Government has not yet formulated regulations concerning the manner in which ships under the American flag shall be loaded in order to insure, as far as practicable, the safety of the people aboard as well as the cargoes in transit. Fortunately, action to this end is reasonably near; and there is now in existence an American Load Line Committee which is headed by an official of the United States Department of Commerce.

The Load Line Committee is empowered to investigate and then to recommend to Congress legislation which will be equitable to everybody concerned and yet add greater security to life and property afloat. Seagoing ships, especially, are exposed to a wide range of hazards incidental to such service and to the uncertainties of wind and wave. These conditions vary with the seasons and with different parts of the world: and the perils may be augmented by low visibility and even by the altered salinity of the waters navigated. The manner in which cargo is stowed in relation to a vessel's draft may also tend to increase or to diminish stability—making the craft able or less able to withstand rough weather.

It is a matter of common knowledge that captains and others responsible for the operation of American ships are not always mindful of the limitations imposed by safety in loading their vessels; and risks are run that every now and then lead to disaster and to loss of life. It were far better that rules be formulated and enforced, even though at times observance may involve a monetary sacrifice. Discretionary observance would be unwise, because human judgment is often at fault and may be misled by chance conditions.

After a fight covering a period of years, SAMUEL PLIMSOLL induced the British Government to prescribe regulations for the loading of seagoing vessels; and ever since the latter "seventies" the merchant craft of that nation have carried plainly painted Plimsoll marks on their broadsides. It is no exaggeration to say that British shipowners and British shippers have reaped a rich reward in consequence, because added security in transit has enabled the vessels to reach in safety the far-flung ports of the Seven Seas in the course of the Empire's trade.

The function of the American Load Line Committee is, in effect, to do for American shipping what PLIMSOLL achieved in behalf of boats operating under the red ensign. The public should stand squarely behind our own committee just as the people at large stood behind PLIMSOLL when the odds seemed desperately against him.

RESEARCH PRODUCES UNIQUE CUTTING MATERIAL

TO the metallurgists of the General Electric Research Laboratory credit is due for evolving a cutting material of exceptional and even extraordinary characteristics. This material, called carboloy, is a combination of tungsten, carbide, and cobalt. The cobalt gives to the new material the strength needed in cutting tools, while the tungsten carbide possesses the extreme hardness required to do the actual cutting.

A paper describing carboloy was read not long ago by Dr. SAMUEL L. HOYT, of the General Electric Research Laboratory, before the American Society for Steel Treating; and the performances of the cutting material promise to revolutionize machine-shop practice in some directions and to lead to astonishing changes in others in cutting or machining a wide range of substances.

Carboloy makes it possible to thread a glass rod; to bore a smooth hole in a mass of concrete; to turn a piece of porcelain in a lathe; and to machine the hardest of steels—a diversity of services that no other known cutting medium is equal to. While the average hardness of ordinary hardened tool steel is 850 on the Brinell scale, and that of the hardest steel is 1,000, the hardness of carboloy reaches 2,000 and more! Tungsten carbide alone has a strength of less than 50,000 pounds per square inch; but carboloy, because of the contained cobalt, has a strength of fully 275,000 pounds to the square inch. Carboloy will scratch a sapphire—next in hardness to a diamond; and a carboloy tool will cut a groove in an emery grinding wheel that would quickly wear away any other cutting tool.

We are informed by the *General Electric News* that "The material retains its strength and hardness at elevated temperatures to a remarkable degree. Tools have been observed

cutting nickel steel when the point of the tool was at a bright red heat, without showing any ill effects. The material has no 'temper' to be 'drawn' by the heat generated, and it is actually much harder than the materials machined, even at elevated temperatures. Steel tools, on the other hand, are frequently softer than the machined materials."

Carboloy is capable of cutting through a succession of metals and materials in machining products in the course of manufacture and of doing this under conditions that ordinarily would necessitate a change of cutting tools. This fact, in itself, indicates that the new material will make it possible not only to save time but to substantially reduce operating expense as well. Carboloy will do work now performed with tools set with black diamonds, and it will stand up to the work where the diamonds would either fail or be ruined. In brief, carboloy has before it a wide and very valuable field of usefulness.

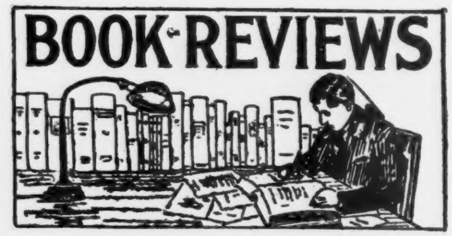
ANOTHER TRUNK LINE TO ELECTRIFY

ONE hundred million dollars are to be spent by the Pennsylvania Railroad in electrifying its tracks between New York City and Wilmington, Del.; and the work will take from se·en to eight years to complete. The total trackage involved will aggregate 1,300 miles, of which 325 miles are devoted to passenger service. If all goes well, as is expected, the whole trackage of the Pennsylvania system, a matter of 11,000 miles, will eventually be electrified, section by section.

To a large extent, the decision to substitute electric drive for steam rests upon the desire of the management to increase its high-speed freight service so as to be better able to handle expeditiously a much larger volume of perishable foodstuffs and to transport other essential commodities with a minimum of delay in transit. The Pennsylvania Railroad is looking well ahead and to the time when the Metropolitan area will have a teeming population of 30,000,000—such may be the number by 1950.

As explained by Gen. W. W. ATTERBURY, president of the Pennsylvania Railroad: "We expect eventually to reduce the number of freight trains 50 per cent for a given car movement and to increase the speed to any reasonable extent required. This, of itself, will provide for a 100 per cent increase in capacity in so far as freight movement is concerned. In the case of passenger trains, we expect to eliminate all double heading and most, if not all, of the second sections of trains, and to avoid the possibility of rough handling due to limited starting capacity, all of which make for greater comfort, better service, and increased capacity of the line."

We have in this magnificent project, which involves the expenditure of a stupendous sum, further evidence of what the foremost of our railroads are doing in one direction or another to provide greater comfort and convenience for their passengers and speedier and better service for their shippers. What is equally significant, these enterprising roads are doing thess things on their own initiative.



RADIO, by Elmer E. Burns. An illustrated volume of 255 pages, published by D. Van Nostrand Company, Inc., New York City. Price, $2.00.

THE popular appeal made by broadcasting radio stations has brought about a widespread grasp of the principles of electrical resonance—a subject that a few years ago was considered among the most difficult in an electrical-engineering course. Thus radio, while entertaining, has helped many to surmount technical obstacles; and it may yet prove the medium by which to grasp other physical principles of still greater significance. As E. F. W. Alexanderson has expressed it: "We think of radio now as a useful system of communication and a delightful form of entertainment, but its greatest significance in the future will be its educational influence. Radio will be the school of training which will educate the engineers, inventors, and scientists of tomorrow, not by the thousands but by the millions."

The present book deals with fundamental principles and with their application in radio circuits. The volume is not intended as a guide in assembling receiving sets—it has a broader and a higher objective.

THE CAVE MAN'S LEGACY, by E. Hanbury Hankin, M.A., Sc.D. A book of 180 pages, published by E. P. Dutton & Company, Inc., New York City. Price, $2.00.

MARK Twain once remarked: "Man is the only animal that blushes—or needs to." He probably made that statement with a full realization of how much we reflect the primitive man in our everyday conduct. With this thought as a text, Mr. Hankin has developed his book, which constitutes an attempt to justify the popular opinion of what is commonly described as "the cave man within us" and the part played by that heritage in influencing our conduct. In short, the author is convinced that many of the things that we do are evidences of what might be termed a primordial "hang over". Just the same he writes that it may be advisable, at the outset, to explain that there is no intention to throw aspersions on the moral character of our presumed ancestor, Aurignacian man. The cave-man influence probably dates from an earlier stage in human evolution. Mr. Hankin has written a very readable book, and it is calculated to enlighten a large number of us.

THIS PUZZLING PLANET, by Edwin Tenney Brewster, A.M. An illustrated volume of 328 pages, published by The Bobbs-Merrill Company, Indianapolis, Ind. Price, $4.00.

ADMITTING that the geology of our planet is puzzling to most of us, the author has essayed to clarify our understanding so that we can have a truer conception of what took place in the past, what is happening today, and what will be likely to occur in the future. The geologist has no reason to [a finalist, because conclusions that seem satisfactory decades ago are often recognize as untenable now. Therefore, though the science of geology deals in a large degree wit things of a relatively permanent nature, sti the scientific interpretation of them changes as opportunities for more exhaustive study present themselves from time to time. Mr Brewster shows us how truly fascinatir the subject of geology may be made for th layman at large; and no part of his enter taining book is deficient in this quality. Most of us would find ourselves the richer in knowledge and gainers in interest in our terrestria setting by a perusal of this volume.

PATRICIA HERALD VERSE, by R. Alpine MacGregor. A booklet of 17 pages, published by the Patricia Herald Publishing Company, Sioux Lookout, Ont., Canada. Price, 50 cents.

WE are told that the booklet, which is unique in appearance and get-up, contains the first batch of verses ever printed in the tall timbers of Northern Canada. The verses breathe the atmosphere in which they were conceived, and should be of interest to those that have knowledge of the tall timbers and life there as well as to those of us that have not yet been brought under their spell.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION FOR 1927. A copiously illustrated volume of 580 pages, obtainable from the U. S. Government Printing Office, Washington, D. C. Price, $1.75.

THIS annual is, as usual, replete with a great deal of information covering the march of science in various fields of inquiry. The topics dealt with include, among others, the mind of an insect; origins of Chinese civilization; lengthening of human life in retrospect and prospect; bird banding in America; fossil marine faunas as indicators of climati conditions; soaring flight; the coming of t new coal age, etc. This compendium is worth many times the price, and is yearly welcome by a large number of readers. The prese volume is no exception to this rule.

CHEMICAL ENCYCLOPAEDIA, An Epitomized Digest o Chemistry and Its Industrial Applications, by C. Kingzett, F.I.C., F.C.S. A work of 807 pages, publishe by D. Van Nostrand Company, Inc., New York City. Price, $10.00.

THIS encyclopaedia now appears in it fourth edition, and contains 200 pages more than did the third edition of this work which was issued in 1924. The reason for the book is the appreciation shown the preceding editions, combined with the writer's desire to make certain corrections and to bring the volume up to date as far as it was humanly possible to do so. The broad purpose of the encyclopaedia has thus been clearly stated by the author: "My aim has been to prepare an epitomized digest of chemistry and its industrial applications in a form which should be useful not only as a work (reference by professional chemists, student and all persons engaged in chemical manufactures, industries, and trade, but also as educational treatise serviceable to all class of the community." This has certainly b achieved.

No. I

cur in
to
eeme
gnize
gh the
e wit
e, sti
nanges
study
Mr
natir
or th
enter
Most
knowl-
estria

cGregor.
Herald
Canada.

hich is
, con-
printed
. The
h they
rest to
imbers
t have

TION FOR
ges, ob-
Office,

with a
ng the
nquiry.
others,
e civili-
retro-
merica;
limati
of t
s worth
lcome
prese

Digest o
y C.
ublishe
ork City.

in it
pages
s work
son fo
he pre-
writer's
and to
it was
d pur-
s been
im has
f chem-
a form
work
udent
manu-
o as a
class
y b